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Index to Advertisers and Classified Index Following Reading Matter.

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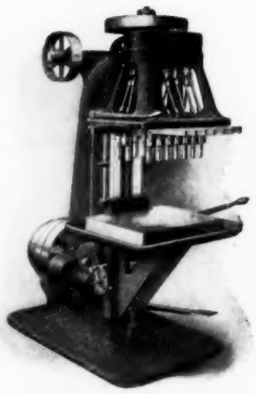

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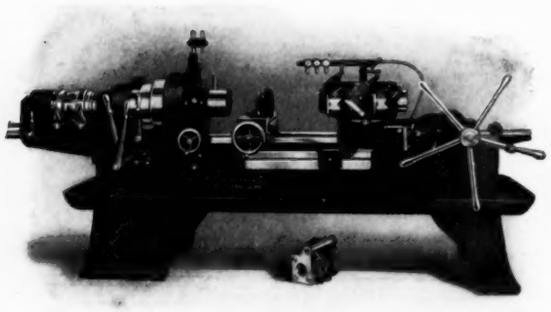

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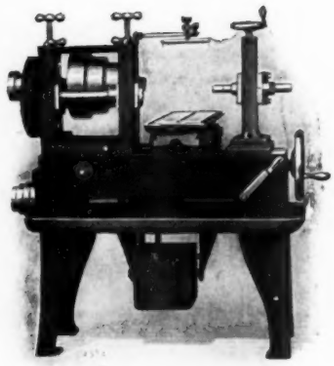
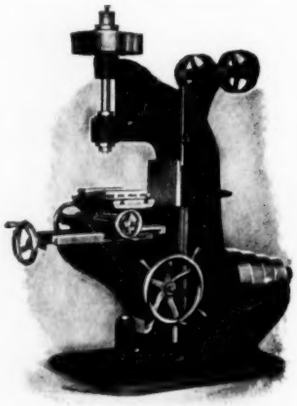
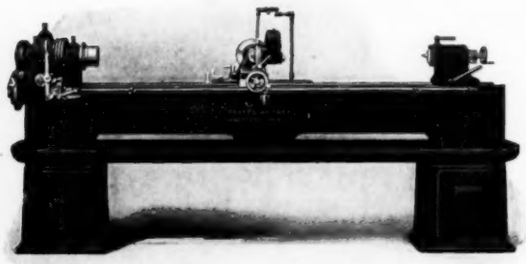


Lincoln Milling Machine.



No. 3 Die Sinker.



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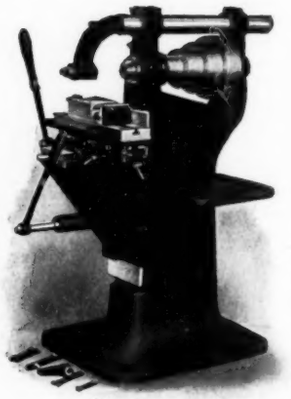
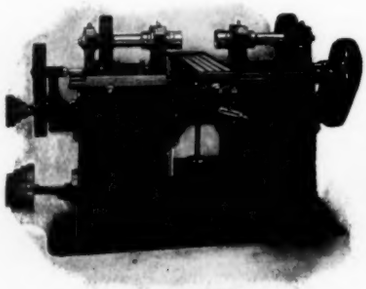
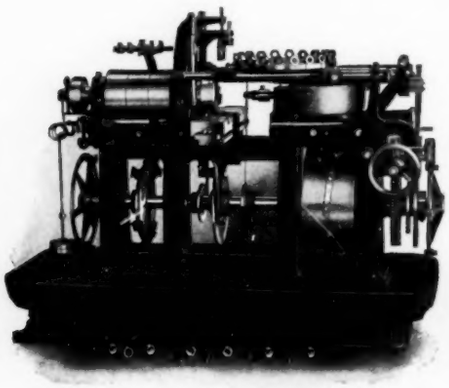


No. 2 Hand Milling Machine.



Double Column Milling Machine.



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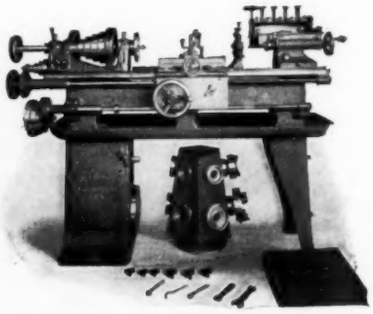

10 in. x 5 ft. Toolmaker's Lathe.

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The Shops and Some of the Methods of the Norton Grinding Company.

Most of our readers are more or less familiar with the work of C. H. Norton, especially that which relates to the development of grinding machines, and of the art of grinding. Employed as a designer in various famous tool-building establishments, Mr. Norton, among other things, had occasion to study the art of grinding and its application to the production of cylindrical and other finished work used in machine construction. He became very much interested in it; believed that the possibilities of grinding were but little understood, and was finally brought by a process not necessary to relate in detail, to the point of establishing what is known as the Norton Grinding Company, whose new shops in Worcester, Mass., and some of the methods followed in them, form the subject of the present article.

A SUPERINTENDENT'S MONITOR BOARD.

The visitor, entering the office, may perhaps notice on a table near the desk of Mr. Norton a board, the arrangement of which is shown in Fig. 1 (which incidentally, is a plan of the works) and which pertain to a method.

For enabling Mr. Norton, the shop manager, to keep track of the work that is going on upon the floor, the various figures upon the board shaped something like the cross section of a T-slot represent grinding machines. They are small pieces of card-board cut to scale and fastened to this board by thumb tacks in the manner shown. Their arrangement in echelon, as the soldiers would call it, represents the positions of the machines that are being erected upon the floor. Each one is marked with the figures indicating its size, so that at a glance Mr. Norton is enabled to see, first: whether or not the erecting floor is filled, if not, then where an additional machine may be put in, and finally if such a machine is not put in, then he is enabled or prompted to ascertain why it is not put in; the object, especially at this time, being to keep the erecting floor as full as possible of machines being completed for shipment.

SHOP ARRANGEMENT.

The shop as will be seen by Fig. 1 is 264 feet long by 80 feet wide. The heavier tools are upon the ground floor, and so arranged that they can be served by the traveling crane which covers the central bay and which is used also in erecting. Upon the upper galleries are placed the smaller tools in the usual manner. At the extreme left hand of Fig. 1 is shown the arrangement for shipping where the side track passes the end of the shop and a car can be run under a shed provided at that place, in which position it can be reached by the traveling cranes, so that work may be picked up from any portion of the floor and deposited directly upon the car.

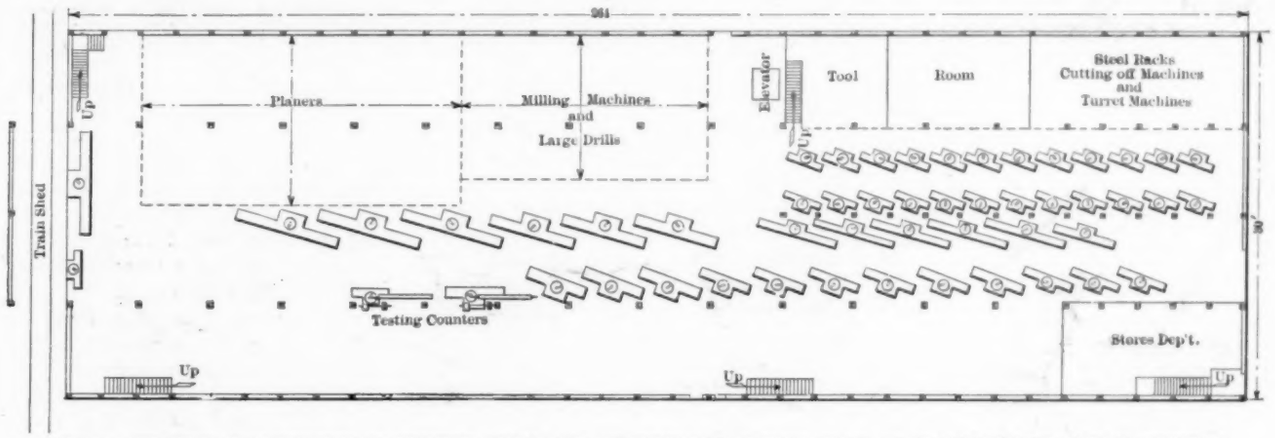


FIG. 1. SHOWING ARRANGEMENT OF MONITOR BOARD AND INCIDENTALLY GROUND PLAN OF WORKS OF THE NORTON GRINDING COMPANY WORCESTER, MASS.

Incidentally, this affords a means of photographing various grinders as they are completed; this end of the works being fitted up as a sort of a machine photograph gallery. The camera is usually placed upon a car, and the machine to be photographd upon the floor to the right of the car in Fig. 1; Mr. Norton making a point of having the distance from the camera to the machine always the same, so that when a collection of photographs or of engravings made from them are exhibited to a customer or other interested persons, the photographs, by their relative sizes, indicate the sizes of the machines which they represent. In other words, being placed at a uniform distance from the camera, the photographs have the same relation to each other in size that the machines have, and there is much less liability of anyone being misled by them.

Arrangements are here made also for controlling the light in such a way that the best possible conditions are secured, and the plan is in every way much better and more satisfactory than the more usual one of taking the camera to the machine to be photographed, instead of taking the machine to the camera, or to the photograph gallery, as is done here.

SOME EXAMPLES OF GRINDING.

After a glance at a full-size chalk drawing of some scheme of a grinding machine to be built by the company for one of the most prominent railway systems, and which is to be used for grinding the faces of steel car-wheels, we pass out of the office door to the gallery where the view Fig. 2 meets the eye. In this view, straight-edges and the manner of handling them in order to produce straight and true guiding surfaces form a prominent feature, but before going on to them, we take a glance at some exhibits on the gallery, just outside Mr. Norton's office door, and facing the view seen in Fig. 2. Some of the features of this exhibit have been shown at various railroads and other exhibitions. They consist, for instance, of a piston rod for a locomotive which has been ground so accurately and so uniformly from one end to the other, that a brass collar closely fitted to it will descend from one end to the other of the rod at a uniform rate by its own weight; the fit being so precisely uniform from one end of the rod to the other, that the resistance to the descent of the collar is so nearly uniform that there is no perceptible difference in the rate of descent. It is a remarkable exhibit and full of significance to him who understands the nature of such a fit and the difficulty of making it by the old method. It is also seen to be of great importance in machine construction, especially when it is remembered that, by the modern method of grinding, such a fit can be produced at as low or a lower cost than the far inferior fit formerly produced by means of turning, filing and lapping.

Another feature of this exhibit is a pair of rolls, one resting upon the other, and arranged to be turned by a crank. These rolls are about 3 feet long, about 12 inches in diameter, and when a strong light is placed behind them, and they are rotated, one can by carefully looking see any space there may be along the line of contact; the observer at first sees no light, and if the fact that he does not has no particular significance for him, or in case he has any doubt as to his ability to see the light between the rolls in case there were any inaccuracy, Mr. Norton will introduce near one end of the rolls, a piece of tissue paper, letting it pass between the rolls; the effect is magical—it seems as though the rolls were very far apart, and very far from coming in contact with each other, though it is likely that under the pressure of the weight of the upper roll, the tissue paper originally thin is really able to raise the roll considerably less than a thousandth of an inch. At the same time close examination of the surfaces of the rolls show that they are just as the grinding wheel left them, and it is apparent that the extreme accuracy to which they have been ground is simply a result of the accuracy with which the guiding surfaces of the grinding machine were finished, and the accuracy with which the relative positions of the axis of the work and of the axis of the grinding wheel arbor were maintained throughout the operation of grinding.

And the accuracy demanded by many of those who use rolls of this kind, is something astounding. Mr. Norton states that in the case of certain rolls used in flour making, an error of half a thousandth of an inch is all that will be endured, and that rolls having a greater error than that do not produce flour of the desired quality or texture.

STONE ROLLS FOR CHOCOLATE.

An interesting case of this kind passed through the works some time ago, in which a pair of rolls used in crushing chocolate were dealt with. It seems that these rolls are made of stone, and that they come from France, where the manufacture of chocolate is an old industry, and has been highly developed. It is customary there to finish a pair of rolls together so that with them the required uniformity of crushing or of grinding can be attained. An American manufacturer, however, who had a pair of these rolls wished them to be finished, or refinished, and sent them to the Norton Grinding Company for the purpose. It was soon discovered that these stone rolls, in order to fulfil the requirements, would have to be finished with the greatest possible accuracy; because any deviation of the nature of the contact between them as they rotated together, made an appreciable irregularity in the quality of the chocolate produced by them, and they were finally satisfactorily ground while rotating upon centers, using fixtures specially arranged for the job attached to a regular grinder, and by means of such a grinding wheel as is used by opticians; at least so far as its texture and grade were concerned.

It is only recently—as our readers know—that it has been considered possible to produce such work as this by an ordinary grinding process. It has been made possible, not only by so designing a machine as to eliminate sources of error, but by taking the utmost pains to secure a quality of workmanship of the highest order; in other words, the guiding surfaces or slides upon which the platen carrying the work moves, must be straight, within the limit required for the work, and this result is secured in the Norton shop by the skilful use of the straight-edges, previously referred to and upon which great stress is laid in these shops.

STRAIGHT-EDGES.

The large sizes in which grinding machines are built by the Norton Company call for unusually large straight-edges, The one, for instance, shown suspended from the crane in Fig. 2 is a Brown & Sharpe straight-edge, 15 feet long and weighing about 1300 pounds. A similar straight-edge 10 feet long is shown at the extreme right, under the gallery. These are used for perfecting the flat guiding surface, always provided at the front of the Norton machine, while for the V guiding surface at the rear, a special straight-edge made in these shops is used; this being shown in position upon the bed of a machine near the right of the central bay. A cross section of this straight-edge is approximately hexagonal in shape and has upon it a number of prismatic surfaces, which have been finished with the greatest possible care, and to which the various V guides are scraped.

These large and heavy straight-edges can, of course, be handled practically only by the crane. When not in use they rest upon the projecting timbers, shown at the left of the central bay in Fig. 2, slightly below the level of the gallery floor. Here they may be picked up by the crane and carried over any machine upon the erecting floor, the practice in this shop being to have one or more scraping gangs operating upon a number of machines at the same time. When the straight-edges are to be applied to these, the crane takes the straight-edge, carries it from one machine to the other and the men do the rubbing, so that at one job, or haul upon the crane, all the machines upon the floor requiring the application of the straight-edge have it applied to them. The straight-edge is then removed, the crane is available for other service and the men go at the work of scraping, not having to call for the service of the crane again until all the machines have been scraped and are ready for another application of the straight-edge.

TESTING AND LIMITS OF ERROR.

The final test of the scraping is made by placing the machine under one of the testing counters, designated in Fig. 1, and putting into it a testing bar, which is supported upon centers and is as long as the machine will take in. This is ground and carefully calipered, the rule being that a bar 4 feet long may be 0.0015 inch larger in the middle than at the ends, but no smaller. A 6-foot bar may be the same; an 8-foot bar may be 0.002 inch larger at the center than in the ends, but no smaller; while a 10-foot bar may be 0.0025 of an inch larger at the center, but no smaller, the reason for this allowance of increased diameter being that, when it occurs it is very readily corrected by the use of the rests, which in the Norton system of grinding are always used, but if the bar should be smallest at the center, then the rests could not correct such a defect, and when it is shown upon the testing floor it is corrected by re-scraping the guiding surfaces of the bed of the machine.

The allowances named are the maximum ones; most of the machines being, of course, well within the limit named. And as these machines are all so arranged that they always rest upon three points, and consequently cannot well be subjected to strains in setting up, or upon the floor, different from those to which they were subjected while being scraped, the results can be depended upon; and a machine which produces certain results upon the testing floor will produce the same results when set up and operated by the user.

As will easily be believed, there are a number of points connected with such work as this which are likely to be learned only by experience, and the men who do it in the Norton shops have naturally become specialists in that particular branch of scraping; Mr. Norton expressing the belief that the man shown with his hand upon the nearer end of the large Brown & Sharpe straight-edge in Fig. 2 is certainly inferior to no other in the art of producing such surfaces as are required in work of this character. In testing the machines, the test bar is measured by the micrometer at every inch of its length, and if the machine grinds larger at the center, the increase of size must be graduated uniformly from the end to the center. And although for special requirements the machine can be made to grind absolutely uniform throughout the length of the bar, they can, where the usual limit is allowed, be made to grind much closer by means of

the rests, so long as the machine does not grind at all smaller in the center.

SPECIALIZATION.

The view Fig. 3 was taken with the camera standing on top of a freight car, which freight car was on the loading track at the end of the shop, as shown in the plan, Fig. 1. The balcony just outside the office, on which the specimens of grinding referred to are located, is seen at the further end of Fig. 3. In these shops the American idea of strict specialization is carried pretty nearly to its extreme limit. Not only is nothing made here except grinding machines, but these machines are of only one kind, namely, those used for producing cylindrical work, and the aim is to develop the art of grinding cylindrical surfaces to the highest possible point; the idea that grinding is only a refining process and nothing more having been boldly discarded, and the claim being unequivocally made that where the roughing cut is taken in the lathe in such a way as to simply remove the surplus metal in the shortest possible time without regard to the character of the surface left, or to any degree of accuracy, the work can then be finished by grinding in these machines, at a total cost considerably below what is possible by any other known method.

To do this, however, as most of our readers know, it has been necessary to discard the old traditions of grinding. Instead of the work being rapidly rotated in these machines, it is much more slowly rotated than has been the practice heretofore, the rotative motion of the work being recognized as in reality the speed motion; that is, the motion which presents the metal to the wheel for action; and the wheel itself, which is much larger and wider than has been the common practice, is advanced nearly or quite its full width for every turn of the work. It is obvious that by this plan every part of the face of the wheel does the same amount of work. It, therefore, has no tendency to round off at the advancing corner, but rather its tendency is to re-

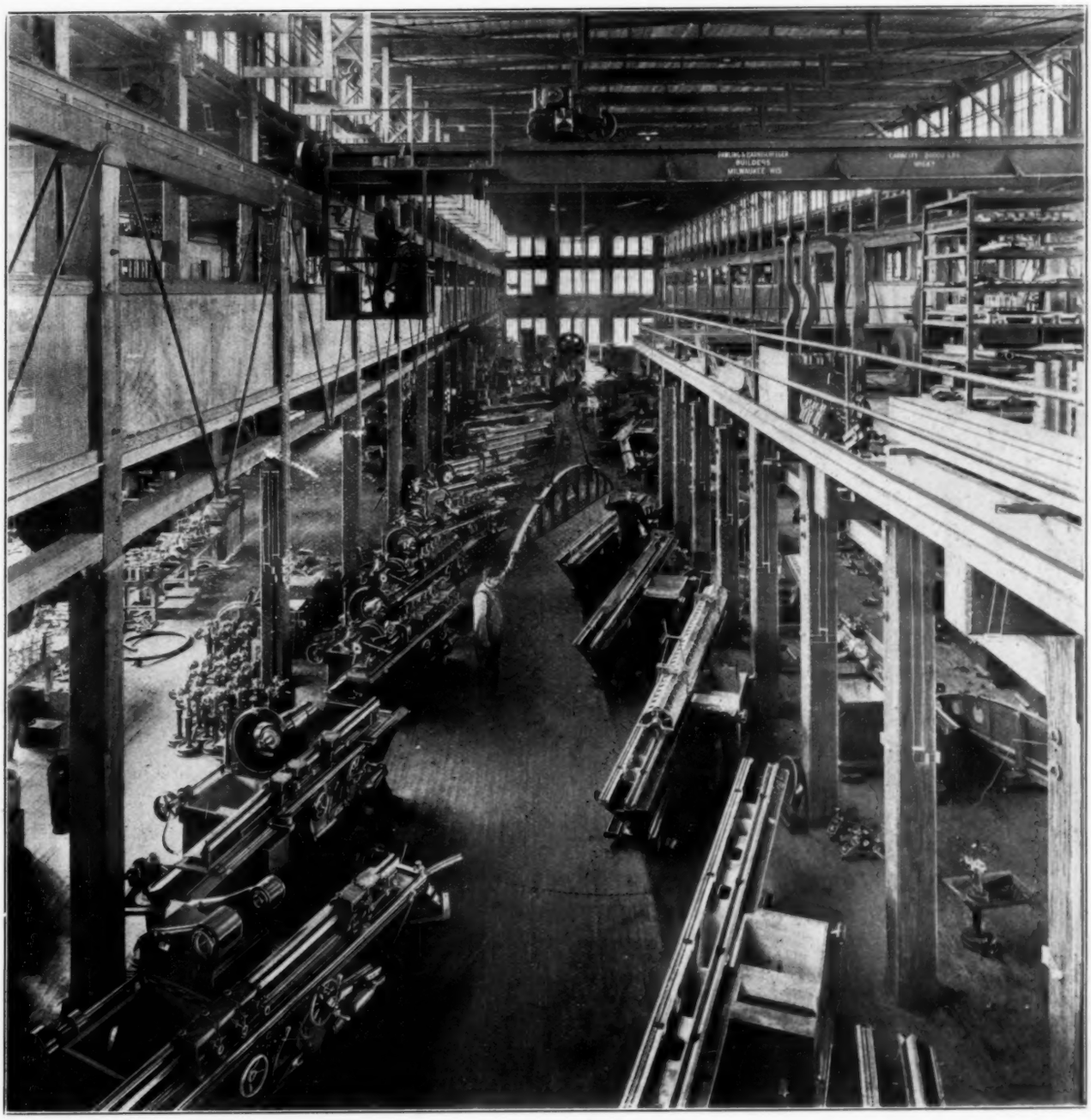


FIG. 2. VIEW IN MACHINE SHOP OF THE NORTON GRINDING COMPANY. TAKEN FROM GALLERY OUTSIDE THE OFFICE DOOR.

main square and retain its flat face. Upon this squareness and flatness of the face of the wheel depends obviously the degree of finish of the work, or its freedom from feed marks, so-called. Upon this accurate formation of the grinding wheel itself great stress is laid in the Norton establishment. Not only must the wheel be flat on the face, but it also must be true, because it is obvious that if the wheel runs out in the least, it will produce a series of corrugations upon the work, the pitch of which will depend upon the relation between the speed of rotation of the wheel and of the work.

This means also, of course, that there must be absolutely no vibration of the work or of the wheel; both must be held with absolute rigidity, and when all these conditions are secured, one by holding his ear close to the grinding point may hear a steady, continuous hum, or as Mr. Norton puts it, the singing of a song, which means the presence of the proper conditions for producing the right kind of work. If this singing has in it the least flutter, or variation of note, then something is wrong, and the practiced ear affords an infallible test of the proper working conditions.

WHEELS MUST SHARPEN THEMSELVES.

As Mr. Norton has explained in our columns, the effort is to so adapt the wheel to the work that, in the grinding operation, the wheel will crumble away sufficiently fast so that new cutting particles will be constantly presented; in other words, the adaptation of the wheel to the work can be such that it will continually sharpen itself, and when a heavy cut is being taken under such conditions, the surface of the work will be relatively quite rough. When, however, the roughing cut has been finished, the diamond is applied to the wheel; this smooths the wheel, and after this a light cut taken over the work leaves it with a beautiful uniform surface, impossible to be produced by any other method than the best grinding.

FOLLOWING DIRECTIONS.

These and other points that have been developed as a result of much study and experience upon the part of Mr. Norton, and others, have led to the formulation of a certain method of procedure in using these machines, and it is interesting to observe in this connection the experience of the Norton company, with some of its customers. It would seem, for instance, that where so much money as is required for a large and heavy machine of this class, has been invested, a natural thing for the buyer would be to closely follow, at least for a time, the directions given by the builder, in the expectation that the experience of the builder would naturally have pointed out the best possible manner of using the machine in a general way, and that changes from the method specified by him ought to be made only after considerable experience, and where it was quite certain that such changes were demanded by the special requirements of the work to be done. It would seem that where specific and plain directions were given, that these directions would be carefully followed. In some cases they are, but in others not, and the results are often curious and in a way interesting. For instance, a machine which had been carefully tested on the floor in the shop, the performance of which was a matter of record and could be accurately and definitely known, appeared to be giving bad results. Complaints came in that it would not finish the work, that it would not do the work nearly as fast as had been claimed, and that the work was rough. Suspecting the trouble, the user was asked particularly if certain points of the instructions given with the machine had been carefully observed. The reply came back promptly that these points had all been carefully observed, but after considerable correspondence, followed by a visit to the works, it was found that there was no diamond in the works for truing the wheel, although the instructions had specifically stated that such truing with the diamond was an absolute necessity, and that no good work could be expected without it. The man who had written the complaining letters, of course believed that all the requirements had been fully complied with, and that every direction had been carefully followed, because the man in immediate charge of the work—more or less careless and in-

FIG. 3. VIEW IN THE MACHINE SHOP OF THE NORTON GRINDING COMPANY LOOKING TOWARD OFFICE GALLERY.

different, or at least little, if at all, interested in the success of the machine—had reported that such was the case. An investigation showed, however, that this report was erroneous, and upon a diamond being used and the directions followed rigidly, the results were as they should have been, and not only was something learned in that shop regarding grinding, but something was learned also by the proprietor regarding the degree of confidence to be placed in reports about new machines in which the men handling them, and those in charge of the men, have little or no interest, and who are too apt, in many cases, to consider that they "have learned the trade," and know how to work machine tools, and don't care to be told how to do this, and how to do the other.

It is such difficulties that the pioneer in any line always has to contend with, and the Norton Grinding Company is of course encountering its full share of them. The difficulties are being overcome, however, and there is evidence that people generally are becoming much more intelligent regarding the operations of grinding, and the points necessary to be observed in order to make a success of them.

FINISHING AUTOMOBILE CRANKSHAFTS.

The methods followed in the Norton shop in the making of crankshafts for automobiles are of considerable interest. These crankshafts have been finished for the manufacturers in very large numbers by the Norton Grinding Company, and the method at first pursued was to use an elaborate set of fixtures which were designed to hold the crankshaft in the lathe and in the grinder, and to shift them from position to position as might be required by the successive operations to be performed upon the shaft itself, and upon the various crank pins; these fixtures being very carefully made and with facilities for making the various changes of position with the greatest possible accuracy.

Experience with these fixtures made it apparent, however, that it was impracticable to get a sufficient degree of accuracy by their use, and to get it with sufficient ease to make the operation commercially practicable. The process now employed is to provide, for each crankshaft of a lot, a fixture, or rather a pair of fixtures, one of each pair being attached to the end of the shaft first prepared to receive it, and which fixture remains in position upon the shaft until the latter is finished, the various necessary centers upon which to swing the shaft being carefully located in these fixtures, so that when the shaft is transferred from one machine tool to another, or changes are made from one operation to another for roughing and finishing, it is certain that a replacement in any given position will be precisely the same as the first placing in the given position. Where for instance, 50 crankshafts are to be finished, a hundred such fixtures are provided—one for each end of each shaft—and the results are declared to be in every way better than with the more elaborate fixtures at first thought necessary in order to handle the work.

Though this shop is a comparatively new enterprise, and though in respect of number of men employed and total value of work turned out, it by no means ranks with our largest machine tool building establishments, it is already very well known abroad and a very considerable proportion of the heaviest machines that have been built in it have gone to England and to Germany; it being a significant fact that these machines, designed for finishing by grinding the heavier parts of marine engines and other heavy machinery, have been rather more cordially and more readily received abroad than has been the case here in America, strange as it may seem, and they are now being used with entire satisfaction on the Clyde in grinding to a finish piston rods, for instance, of marine engines which were formerly finished exclusively by the old-time methods of the skilled lathesman; and the work is not only done at considerably lower cost, but in a manner so much superior as to scarcely leave room for comparison.

Recently there has been a revival of the discussion of the subject of hazing, which is popularly supposed to be confined to schools and colleges. This is by no means the case, however, but it is prevalent in work shops and manufacturing establishments, only it does not there usually go under that name. In such establishments, one who will allow himself to be imposed upon will inevitably be annoyed by what is in effect "hazing" and the report of an example of this comes from Middletown, N. Y., where in a railroad shop a sleeping employee was severely and perhaps fatally burned by an unknown miscreant, a fellow employee, throwing upon him a burning bunch of greasy waste while he slept in the cab of a locomotive.

The Tantalum lamp is said to have an efficiency of more than double that of the ordinary carbon-filament lamp of the same voltage and candle-power, consuming at the outset from 1.73 to 1.93 watts per candle-power as against 3.5 to 4 watts per candle-power for a good incandescent lamp. The life of the Tantalum lamp is rather short, being about 500 hours, and the filament used has a tendency to soften and become friable with use.—*The Engineer.*

The man that is going to do something tomorrow is all right, only he is a day behind time.—*The Wood-Worker.*

The Young Inventor and the Engineer.

The young inventor's eyes burned.

"It will revolutionize—revolutionize—well, it will revolutionize things," he cried.

He pushed away his plans and specifications, his compass and his rule, and sat back in his chair, flushed of face and swelled of brow.

"There are millions in it," he declared.

And therewith he hied him to a consulting engineer, his plans and specifications under his arm and joy around his heart. He closed the doors of the engineer's inner office and took a side glance at the window ledge outside.

"Can anyone overhear us?" he whispered.

"No, no," replied the engineer.

"And will you hold my words in strictest confidence?"

"Yes, yes," replied the engineer.

(He, too, seemed to think that there were millions in it, showing his thought with subtlety but plainly).

The young inventor shook hands with him to bind the promise and then unrolled his drawings. With one motion he placed them before the engineer's nose and then with a smile of confidence he waited for the engineer to cry aloud in an ecstacy of admiration and excitement.

But the engineer didn't.

"What is it?" he asked instead.

With burning words the young inventor told him.

"Of course it isn't finished yet," he concluded," but with a cam in here and a lever in here and a little jigger to take up wear and tear and make it automatic—eh?"

"I see," said the engineer. "I see."

He pushed the drawings away and sized up the young inventor.

"You want me to get up working drawings?" he asked.

"For a model," nodded the inventor.

"My charge is fifty cents an hour."

"And how long will it take?"

"Not long," replied the engineer.

(The young inventor deduced from the engineer's manner that it would take about two hours. The engineer didn't say this but he expressed it unconsciously but unmistakably.)

"And what do you think of it?" smiled the inventor.

"You know what I think of it," exclaimed the inventor.

"And how about any little things you may add to it?" asked the inventor; "would you try to patent them yourself?"

"I never patent anything," announced the engineer.

(Which the young inventor thought was strange.)

But away he went with burning eyes. In the engineer's anteroom he met a chuckle-headed idiot with drawings underneath his arm. "Durn fool," thought the young inventor; "what could *he* invent?"

And off he went enveloped in a haze of dreams, through which he saw his invention revolutionizing everything in sight and millions pouring in upon him.

"I will buy one of those big automobiles," he told himself in secret.

The next day he called upon the engineer.

"Drawings ready?" he cried.

"Oh, no," remarked the engineer. "The draughtsman that I want to work on this particular job is away in Brooklyn on another job, but he'll be back tomorrow. Of course I could get any ordinary draughtsman to work on this, but—you understand"——

The young inventor understood.

There followed a dissertation by the engineer on the importance of correct working drawings: how much easier it was to erase a drawing than to change a casting; how he once had a good draughtsman who "spent ten days, by Jingle Bell, over one single nut," and the large amounts of money ultimately saved thereby; how he once made up a set of working drawings that cost thir-ty-six-thousand-dol-lars, and much more to the same effect, so that when the young inventor went away he thought it might cost him as much as $10 to get his drawings.

The next day all this was repeated with variations.

And the next.

The young inventor grew nervous.

"Do you charge for your time?" he asked.

"Only the usual rates," beamed the engineer.

When the young inventor had at last been reduced to despair he called at the engineer's office one morning and found a man working over the sketches of his revolutionizer, so that when the young inventor left late that afternoon his eyes were burning again and he saw millions in it, corporations, syndicates, trusts and all that kind of thing. The next day he was plunged to the depths, for it was evident that the draughtsman was an ignoramus and was spoiling everything. The engineer was appealed to and details were at last straightened out. Again the young inventor left enwrapt with thoughts that warmed him.

A month passed and the young inventor did everything but weep. In his bitter moments he invented names for that ignoramus of a draughtsman, calling him in fancy a bearded swine, a nawful numbskull, a nass and other harsher terms. But at last everything was finished but one little screw, and at this point the engineer himself took hold.

They discussed it. They conferred over it. They leaned far over the drawings and wrestled with it. They sketched it. They traced it. They laid it out actual size. They laid it out to scale. They showed a side elevation of it. They showed an end elevation of it. Thew showed a plan. And still it wasn't right.

They changed its position. They countersunk it. They put a washer on it. They consulted authorities. They pored over old plans. They made it with a cone head. They made it with a steeple head. They put a little spring about it. They scowled at it. They adjectived it. And at last, just as the young inventor was giving the thing up, the trick was done.

Engineer's bill, $154.

The young inventor went out and borrowed the money.

"This inventing," said he, "isn't all it's cracked up to be."

He went to a machine shop and showed his working drawings.

"It won't go together," said the superintendent at once. He went over the drawings a second time and his lip curled with scorn. "Who made these drawings?" he scoffed.

The young inventor told him.

'What!" laughed the superintendent, *"Him?"*

There followed an era of pattern making, casting, machine work, assembling, changing, new patterns, new castings, new machine work, new assembling, new changing, different patterns, different castings, different machine work, different assembling, different changes, further patterns, further castings, further machine work, further assembling and then all over again. Three times the young inventor was called upon to deposit $100 as an evidence of good faith, and on the fourth call for additional margin he quit.

"A model isn't necessary, anyway," he argued. "I will get it patented and sell the patent."

He went to a patent attorney and told his tale.

"Who made the drawings?" asked the attorney.

The young inventor told him and the attorney laughed.

"And who did your machine work?" he asked, and again he laughed. He buried himself in a file of patent reports and soon raised his head.

"Here's the identical idea patented in 1867," he mentioned; "you couldn't get this thing of yours patented in a thousand years. Anyhow, they arn't using those things any more."

And looking behind him at his fourteen weeks of labor and disbursing, the young inventor went away with a lightened heart and swore that thereafter he would confine himself to getting back his neglected trade in baled hay and rock-salt in the livery stable line. *The Evening Sun.*

If a monkeywrench is used so that the pull on the handle is in the direction in which the jaws point, it will stand twice as much strain and is not half as likely to slip as when the pull is the other way. —*The Wood-Worker.*

Your future is being made *now.*

English Results With High-Speed Steel.*

LATHE WORK.

In connection with heavy cutting, it will be interesting to refer to the powerful lathe constructed by the writer's company for the purpose of demonstrating the powers of A W. steel at the Liège Exposition. The massive proportions of the lathe, which is of 18-inch centers and driven with a 60 horse-power motor, will be gathered from the illustrations, refers to foot note above, while Table 1 will convey some idea of the possibilities of the cutting powers of the A W. steel in this modern machine tool.

Brand of Steel Used.	Material Cut.	Cutting Speed, Ft. per Min.	Reduction in Diameter.	Feed per Revolution	Weight of Metal Removed per Hour.
				Ins.	Lbs.
A W.	Forged steel	160	3/8	1/16	611
A W.	"	100	2	5/8	2,545
A W.	"	42	2	3/4	2,140
A W.	"	33	1	3/8	1,935
A W.	"	32	2 1/8	1/4	2,039

TABLE I. WORK OF THE 60 HORSE-POWER LATHE.

In the early stages of the development of high-speed steel it was frequently found that but moderately successful results were obtained when cutting hard varieties of steel and gray iron. Greater experience in its use and manufacture has now enabled these early difficulties to be overcome.

MILLING.

Attention may be drawn to the machine shown in Fig. 1, which was specially designed and constructed for the purpose of demonstrating the milling powers of the A W. cutters shown at the Liège Exhibition. This machine is driven by a 40 horse-power motor, and Table 2 will convey some idea of what we may expect being able to regard as good practice in the near future.

DRILLING.

Perhaps one of the most useful of all the applications following the development of high-speed steel has been the manufacture of twist drills from it. In former days many attempts were made to produce twist drills from the ordinary self-hardening steel, with usually but indifferent success. Now, however, drills of high-speed steel are to be found in most shops, and it is certainly to the credit of British engineers that they have responded so energetically to the demand for them, with the result that they are now sending twist drills of high-speed steel to all parts of the world. This is but another instance of the very rapid progress made with the

*Abstract from a paper read before the Glasgow and West of Scotland Foremen Engineers' and Iron Workers' Association, by J. M. Gledhill, of Sir W. G. Armstrong, Whitworth & Co.

† Page 352, Vol. 28, Part 2.

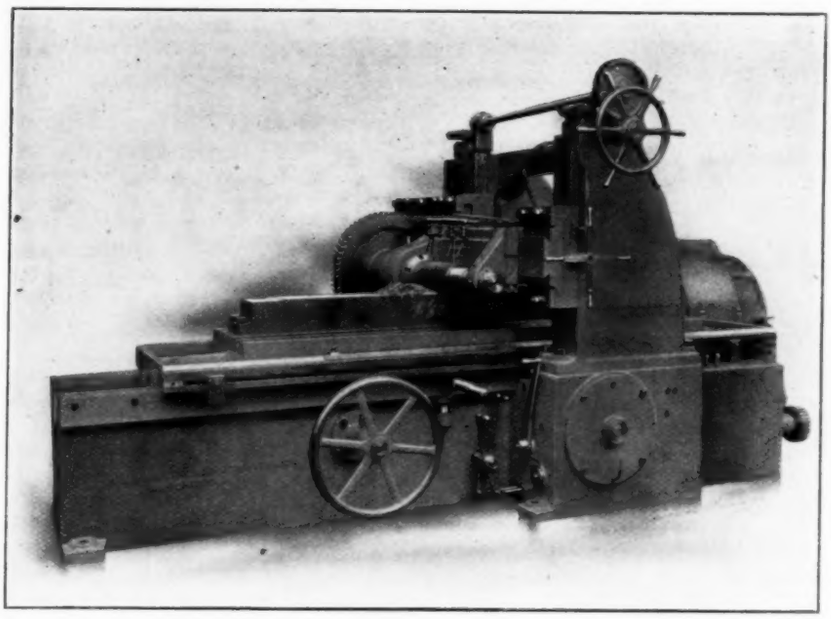


FIG. 1. FORTY HORSE-POWER MILLING MACHINE.

steel during recent years. At the present time "high-speed drills" are so listed and described; the drills for slower cutting being described as "ordinary." The writer is perhaps not alone in venturing a prophecy that ere long, high-speed drills will be "ordinary," and slow-speed drills "special."

A letter received from a large firm of structural engineers in Glasgow who are using A W. drills, contained much valuable information from which the following extract is quoted:

"Drilling mild steel 2½-inch thickness, made of 5⅜-inch plates, and one ⅝-inch angle iron, a 15-16 inch diameter A W. twist drill, running at 275 revolutions per minute, with a feed of 75 cuts per inch of penetration, drilled 7.924 holes without requiring regrinding, each hole being drilled in 42 seconds."

Referring to the trials made by the writer's firm, these have been of a very severe nature indeed, and were made in a new radial arm machine of their own manufacture, designed for using high-speed drills and fitted with positive geared feeds, the width of the driving belt being 5 inches and giving ample power. For the purposes of the trials a number of drills were taken from stock, so that the results would be representative of the capacity of drills usually manufactured. The results show beyond any possible doubt that under ordinary conditions and in suitably designed machines it is practically impossible to break these drills. The machine referred to is shown in Fig. 2, and the plates drilled in Fig. 3.

These results it will be seen show the high-speed drills to possess great torsional strength, for with a feed of 46 cuts per inch (0.21 inch per revolution), when drilling steel of the strength and depth stated, and with the size of drills used, the test in this respect is indeed a severe one. Of course it should not be inferred from these results that it is advisable to always work drills at such speeds and feeds, for the latter especially is dependent to a very great extent upon the character of the work being drilled, and also the rigidity and excellence of the machine used, and it cannot be expected to obtain such results unless the machines are up to the work the steel will do.

MACHINE PARTS.

The A W. steel has also been used with success for lathe centers in the movable headstocks,* and a comparison with similar centers of ordinary crucible steel resulted as shown in Table 4, three centers of each brand of steel being used.

Centers Nos. 1 and 2 of A W. steel are old centers, each having worked continuously for six months, and have not been re-hardened. The No. 3 center was new from stock. The centers of ordinary carbon steel were all new, not having been previously used.

*Tailstocks.—Ed.

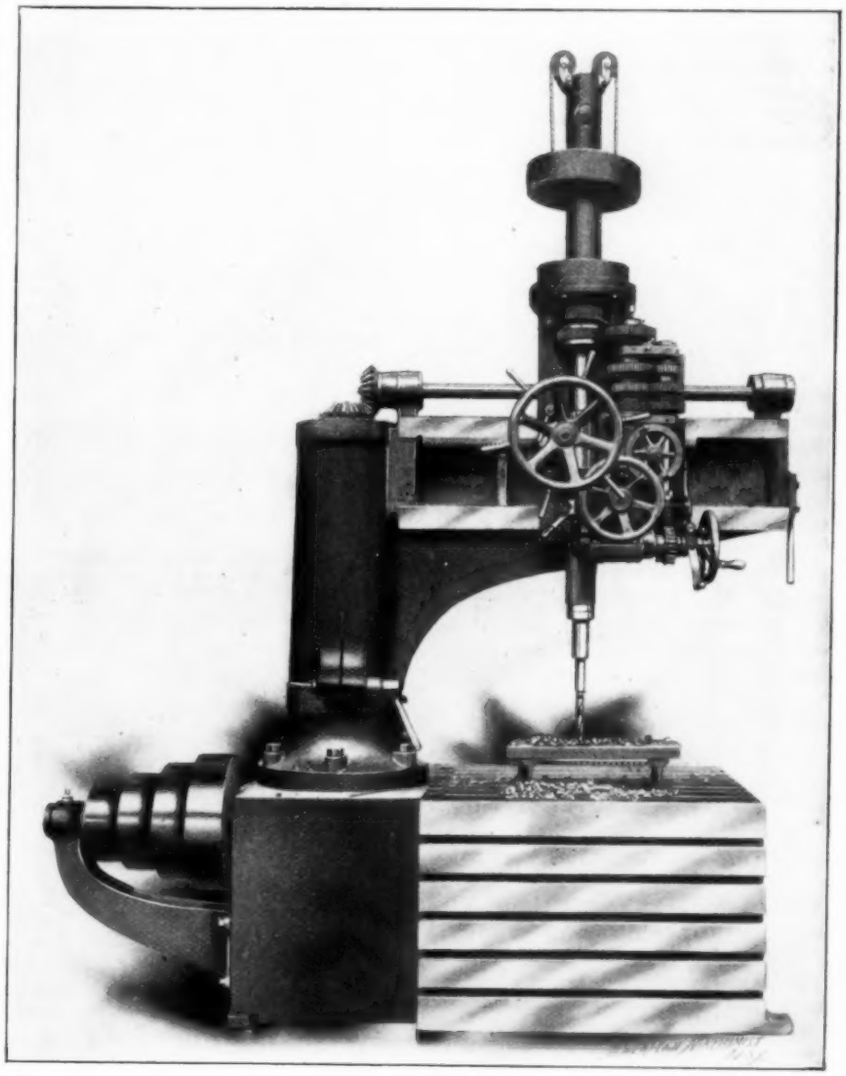


FIG. 2. HIGH SPEED DRILLING MACHINE.

The centers made of this steel are very much tougher than those of carbon steel, the breakages averaging less than 30 per cent. of the latter.

The superior wearing qualities of high-speed steel were also evidenced when used for steadies in a high-speed turret lathe, a comparison showing more than 20 to 1 in favor of A W. compared with steadies of ordinary steel.

Results equally successful have followed the use of high-speed steel for tube expanding tools, tappets for Corliss valve gears, sprocket wheels, and many other instances when it is required to withstand hard wear.

FINISH CUTS.

Doubts have arisen at times as to whether high-speed steel would take finishing cuts. In the early stages of its manufacture, such contentions were somewhat justifiable, but with the knowledge gained from its use, together with greater experience and knowledge of its manufacture, the early difficulties have been largely overcome.

The writer wishes it to be understood that he does not state that rapid cutting steel will produce a high finish under all conditions, for with certain metals a special carbon alloy steel—suitable for hardening in water, will give greater satisfaction, but on the other hand, there are very many operations where high-speed steel will produce the desired finish, and by reason of greater endurance, continue to work for very much longer periods than water hardening steels, and in such cases there can be no doubt of its advantage for this work. In fact, many instances could be quoted where ordinary steel has failed and been successfully replaced with high-speed steel.

A striking example of this is shown in the production of pyrometer cylinders. These cylinders are made of mild steel in an automatic machine made by Albert Herbert, Ltd., of Coventry, and the limit of error allowed in weight is only 5 grains. With A W. steel an average production of upward of 1,000 is obtained without grinding, whereas when using ordinary steel, the tools require grinding after producing 190 cylinders only. Several cylinders are shown for inspection, and the good finish can be judged from an examination of them.

This finishing and enduring quality is especially advantageous for use in the automatic class of machinery, and whenever it is desired to produce work in quantities of uniform size and weight, the great resistance of the steel to wearing insuring work of a high degree of accuracy, and saving much time that would otherwise be spent in sharpening and setting of the tools.

EXAMPLES OF WORK FROM ALFRED HERBERT, LTD.

These samples, shown in Figs. 4 to 16, are not intended to illustrate what in our opinion is the largest amount of metal which can be removed in a given time (this regardless of finish), but what we consider to be a good time for producing a good job, and all the reductions on the samples were taken at one cut; no finishing cut is taken, and no filing or polishing is done.

Fig. 4. This is 13⅜ inches long, and was machined from a bar slightly larger than the size of the largest diameter in 14 minutes.

Fig. 5. This is 31 11-16 inches long, made from tool steel, and was made from a bar slightly larger in diameter than the collar; time, 23 minutes.

Fig. 6. This is 30 13-16 inches long, was made from a bar ¼ inch larger in diameter than the collar; this is rather a slender job, and was machined in 25 minutes.

Fig. 7. This is a bolt 8 9-16 inches long, was turned from a bar ¼ inch larger than the collar, and was machined in 4 minutes.

Fig. 8. This is a bolt 9½ inches long, was made from a bar ⅛ inch larger in diameter than the collar, and was made in 5¼ minutes.

Fig. 9. This is a handle 8 inches long, and was machined from the bar in 3½ minutes.

Aluminum and lead will not alloy. They mix when melted, but separate when cooling.—*The Brass World.*

Brand of Steel and Size of Cutter Used.	Material Cut.	Cutting Speed, Feet per Min.	Metal Under Cut.		Travel per Min.	Weight of of Metal Removed per Hour.
			Depth.	Width.		
A W. 6 in. dia. × 12 in. long...	Forged steel	192	⅛ in.	7⅛ in.	8 in.	157
A W. 6 in. dia. × 12 in. long...	"	180	⅛ in.	7⅛ in.	6 in.	382
A W. 6 in. dia. × 12 in. long...	"	75	1¼ in.	7⅛ in.	1.2 in.	191
A W. 5 in. dia.....	Gray iron	107	⅜ in.	6 in.	4 in.	305

TABLE 2. WORK OF THE 40 HORSE-POWER MILLER.

Diameter and Brand of Drill used.	Material Drilled.	SPEED.		FEED.		No. of Holes Drilled.	Condition of Drill.
		Revs. of Drill per Minute.	Cutting Speed feet per Minute.	Cuts per inch of Traverse.	Feed inches per Minute.		
1 A W. High Speed	Two ⅜ in. Steel Plates secured together.	497	130.1	46	10.8	50	Good
¾ "	"	497	97.6	46	10.8	50	Good
⅝ "	"	497	81.3	46	10.8	50	Good
½ "	"	497	65.	46	10.8	50	Good
⅜ "	"	497	48.8	46	10.8	50	Good
¼ "	"	497	32.5	46	10.8	28	End of Drill broke
33/32 "	2 in. Gray Iron Plate	630	129.0	35	18	400	Good

NOTE.—497 revolutions represent the maximum speed of machine.

TABLE 3. WORK OF HIGH-SPEED DRILLS.

Brand of Steel used.	No. of Forgings turned.	Condition of Center.	Brand of Steel used.	No. of Forgings turned.	Condition of Center.
A W (1)	248	Broke	Ordinary Carbon (1)	30	Broke
A W (2)	557	Required re-grinding	" (2)	230	Required re-grinding
A W (3)	860	Uninjured	" (3)	248	" "

TABLE 4. WORK OF HIGH-SPEED STEEL LATHE CENTERS.

The Foreman in India.

One of the first changes which becomes necessary when an industry exceeds the capacity of one family, and calls for additional workers, is the appointment of a foreman, or *maistry*. The head of the family can no longer give his whole attention to work, for the product has now increased sufficiently to call the head away from actual supervision in order to attend to commercial affairs. So he appoints someone to represent his authority in the execution of the work, and upon that person depends in a large measure the success of the industry. The duties of the maistry are important; he has to maintain order and punctuality, to check waste and idleness, to exercise the eye of an expert on all processes, to see that tools and appliances are maintained in good working condition, to see that each worker produces the proper quantity and quality of work per day, to check peculation and quarreling, and to observe the quality of all materials supplied for his industry. In addition to all these he should be honest, and reliable in the absence of his master. It is plain that the maistry is no ordinary man, and having so many responsibilities, his power for good or evil is considerable. Much of the profit of the work depends

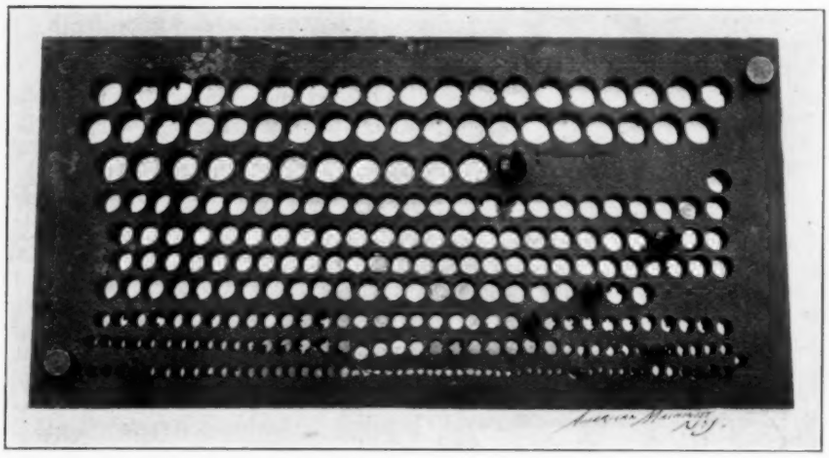
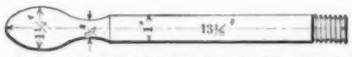
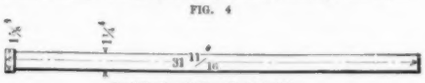


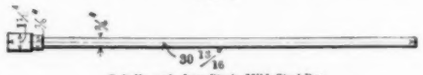
FIG. 3. SAMPLE OF DRILLING WITH HIGH SPEED STEEL TWIST DRILLS.



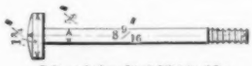
Handle made from Black Mild Steel, Bar on No. 2 Hex Turret Lathe
Time 14 minutes. Cutting speed 55 ft. per minute. Feeds 62 per inch travers
FIG. 4



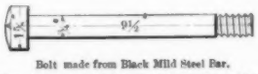
Feed Shaft made from Tool Steel Bar.
Time 23 minutes. Cutting speed 44 ft. per minute. Feed 62 per inch traverse
FIG. 5



Spindle made from Black Mild Steel Bar.
Time 25 minutes. Cutting speed 46 ft. per minute. Feeds 92 per inch travers
FIG. 6

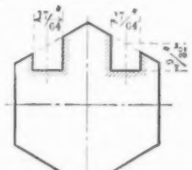


Bolt made from Black Mild Steel Bar.
Time 4 minutes. Cutting speed 197 ft. per minute. Feeds 62 per inch traverse.
FIG. 7

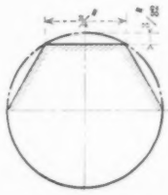


Bolt made from Black Mild Steel Bar.
Time 5⅓ minutes. Cutting speed 133 ft. per minute. Feeds 62 per inch traverse
FIG. 8

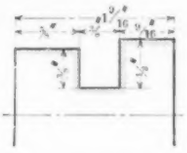
Handle made from Black Mild Steel Bar.
Time 3½ minutes. Cutting speed 126 ft. per minute. Feeds 62 per inch traverse
FIG. 9



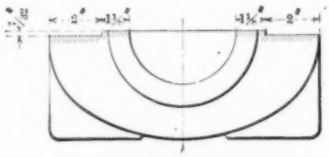
Milling Slots with Two Cutters.
Cutting Speed 167 ft. per minute. Feed 8½ in. per minute.
Cuts 5/16 in. deep, ⅝ in. wide. Mild Steel
FIG. 10



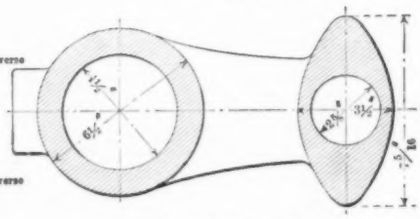
Milling Hexagon Stop Rods for Turret Lathe on Three Sides.
Cutting Speed 90 ft per minute. Feed 4½ in. per minute.
Cuts ⅛ in. deep, 3 in. wide. Mild Steel
FIG. 11



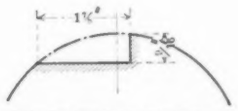
Milling Mild Steel for the Box Tools.
Cutting Speed 150 ft. per minute. Feed 5 in. per minute.
Cut ⅛ in. deep, 1¾ in. wide. Mild Steel.
FIG. 12



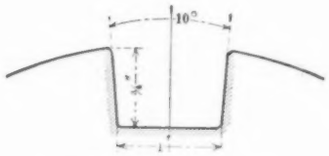
Milling Caps with Gang Cutters.
Cutting Speed 70 ft. per minute. Feed 4 in. per minute.
Cuts ¼ in. deep, 3 in. wide. Grey Iron.
FIG. 13



Milling Faces of Arm (shaded)
Cutting Speed 67 ft. per minute. Feed 3 in. per minute
Cuts 5/16 in. deep, 5 in. wide. Grey Iron.
FIG. 14



Milling Cast Steel Turning Ring for Turrets.
Cutting Speed 50 ft per minute. Feed 2 inches per minute.
Cuts ½ in. deep, 2 in. wide.
FIG. 15



Milling Cast Steel Locking Rings for Turrets.
Cutting Speed 40 ft. per minute. Feed 2 inches per minute
Cuts ¾ in. deep, ¾ in. wide.
FIG. 16

American Machinist

ENGLISH RESULTS WITH HIGH SPEED STEEL.

on his exertions, so he is worth a good deal more than an ordinary skilled workman. We have mentioned his most desirable good qualities, the qualities his employer should look for on engaging him, and to do justice to the subject, we must not neglect to enumerate his possible vices. He may be idle, careless and without sufficient special experience; he may lack vigilance and tact in the management of men, and be without that ready resource and watchfulness that is quick to see a defect in any method or to devise changes that may facilitate work. He may have relatives whom he wishes to place and maintain even if they are incompetent—a constant source of ill-will in any work-shop, and he may levy blackmail on his subordinates and on all furnishers of supplies to the workshop. He may also sell the trade secrets of his master to rivals for a bribe, and rob him in other ways, and many of these things he may do successfully and with impunity if he is clever enough. It is a singular fact that many a maistry expends enough of real ability in the crooked methods of rascality to secure for him an honorable position if only properly directed. But he continues to be a petty rogue, because it is his nature.

We have recently made inquiries among employers of labor on this subject, our object being to ascertain if maistries are multiplying in proportion to the increase of industry, and if they possess the qualifications that are necessary at a time when competition is growing keener, and when the necessity for efficient and reliable workmen becomes more urgent. On the whole the information is disappointing. Our first informant, an engineer who has been for thirty years in India, says that good foremen are scarcer now than they were twenty years ago; schools seem to have done nothing to improve them. They cannot be depended on to set out work from a drawing, or to control efficiently the execution of work; they are very often dishonest, levying blackmail on subordinates and dealers; they do not remember instructions, and, if educated, are deficient in practical experience and in the faculty of controlling men.

A leading cabinet maker says that good foremen are very hard to find. All those he has had have been trained entirely in the workshop, and have had very little schooling. They come from the ranks of workmen, are difficult to manage, and need constant supervision. They have often a workshop of their own with or without the knowledge of their employers, and they do not hesitate to carry off their employer's workmen on occasion, for special jobs. This private workshop serves the purpose of a club, which will keep the foreman from want if he falls out with his master, and he not unfrequently seeks for and obtains work among his master's clients. Repeated inquiries among masters and managers have

brought replies that are only variants of those just given. A few have good foremen of whom they speak in high terms, but they ruefully admit that to replace them would be exceedingly difficult. Good pay in India does not secure a good man as it does in Europe. Architects trained in Europe find the conditions of work woefully changed when they come to India. They may specify their conditions of workmanship and discover that the contractor, the foreman, and the workmen are all dead against them. Clients are found to be well up in the lowest, or what are popularly called "cheapest" rates for work, and they expect that the cost of their building will be as low, or if possible lower, than these rates. We have never found a plumber maistry in Bombay, who could make a drawing, or measure up a piping job in a building, prepare it at the workshop, and fit it in place without correction.

In the matter of honesty it must be admitted that the Indian maistry has little encouragement. His Indian master, be he rajah, manufacturer, or merchant, does not base his pay on the importance of his position as an economic factor in a system, but upon his chances of peculation and illicit gains. The maistry's dishonesty is taken for granted; he is assumed to have means of gain of an unknown amount, and he is deliberately underpaid accordingly. But if he is found out, he is dismissed as a rogue—but with a flattering certificate. This may be generally described as the "custom of the country," and although it does not apply to every individual employer, it may be regarded as a general rule.

Meanwhile the need for competent foremen is increasing, and we do not seem to be getting nearer to an adequate supply. Workmen will not go to night schools as they do in Europe: their children do not stay long enough at school to get a fair start in primary knowledge, and the knowledge given in most primary schools is not the best calculated to open the mind of a young craftsman. Some of the children may obtain a scholarship and spend some time in a school of arts or in some industrial school, but as yet there are no trained teachers of handicraft for children, the men in charge being generally selected workmen, who are skilled in their own line, but are quite ignorant of teaching. Waste of time (in skulking), waste of labor (by bad methods of work), and waste of material (by careless workmanship) are the three capital faults attributable to the Indian workman, which have to be corrected by a far more rigid and constant supervision than is necessary in Europe. The Indian foreman should be a trained teacher of the craft he belongs to, alert, full of resource, good tempered, but firm. Above all, he must know just to what extent he may push his reforms so as not to get beyond the capacity for progress of his subordinates. His difficulties in the way of self-improvement are great on account of the scarcity of vernacular literature. The education of foremen is a subject which appeals in a constantly increasing degree to employers of labor, especially to employers on a large scale, who have to depend so much on hired assistance. If the employer sends an overlooker to a technical school he will be put through such courses as are going at the school, although only a very small part of the new knowledge may apply to his daily work. It may also easily happen that the new labor of study may be too much for his habit of mind. The man may be good enough to be worth improvement, but the improvement must be on familiar and strictly limited lines, if satisfactory results are to be obtained. His value to his employers may be much increased by clearer and more definite ideas regarding certain parts of his work. Schools are to be found in many large manufactories in Europe showing the importance attached to special instruction by European employers. Indian workmen are still in greater need of improvement in matters which affect their efficiency, for their natural rate of progress is far too slow to meet the industrial requirements of the country.—*The Indian Textile Journal.*

It is stated that a well made maple pulley may be run with safety at a rim speed of 154 feet per second, which corresponds to 1.75 miles per minute. This may be true but it is of importance only as showing the factor of safety, for at any such speed a belt would practically cease to transmit power, owing to the action of centrifugal force. Laced leather belts transmit a maximum of power at about 5,250 feet per minute and riveted belts at 6,325 feet per minute. Above those speeds the power transmitted rapidly falls off and at 9,250 feet per minute the power transmitted would scarcely be appreciable supposing a belt could be made to stand such a speed.

More men are killed and maimed in Allegheny county, Penn., in peaceful pursuits in one year than were killed in many of the great battles of history. Statistics for the past year show that there were killed and injured in the iron and steel mills and blast furnaces, 9000. In other mills, shops and factories 4000 were sacrificed, while the coal mines swell this figure by 400, and the railroads' victims include an additional 4300, making up a grand total of 17,700 who were slaughtered or injured in one year. In addition to this number, there are thousands of cases that are not reported.—*Machinist's Monthly Journal.*

There is said to be an increasing demand in China for medium-power gasolene and oil engines.— *The Engineer.*

Results of the Official Test of the Engines in the New York Subway Power Station.

One of the big engine and generator units in the Interborough Rapid Transit Companys' power house at Fifty-ninth street and Eleventh avenue, New York City, was recently selected as representative of the entire installation and given an official test, this unit with seven boilers and the steam and water mains, pumps, etc., being isolated from the rest of the plant during the test. The power house contains nine of these 7500 horse-power Allis-Chalmers engines, each driving a 5000-kilowatt Westinghouse three-phase 25-cycle alternator, delivering current at a nominal potential of 11,000 volts. The engines are double compound, each side consisting of a horizontal high-pressure and a vertical low-pressure cylinder connected to the same crank pin. The dimensions of the cylinders are 42 inches and 86 inches by 60 inches, the high-pressure cylinders having poppet valves and the low-pressure single-ported Corliss valves. The results of the engine trial, made December 6, 1905, are as follows:

Duration—15 hours.
Preliminary operation on load—2 hours.
Load (switchboard reading)—5079.2 kw.
Friction and eccentric losses—417.3 kw.
Total load—5496.5 kw.
Indicated horse-power—7365.3.
Revolutions per minute—75.02.
Steam pressure gage—175.18 lb.
R.-H. receiver pressure—19.1 lb.
L.-H. receiver pressure—19.27 lb.
Vacuum—26.02 in.
Barometer—30.5 in.
Temperature injection water—42.36° F.
Temperature R.-H. discharge—74.05° F.
Temperature L.-H. discharge—77.38° F.
Water per hour—89,906 lb.
Weighed leakage per hour—512 lb.
Leakage per hour (leakage test)—1470 lb.
Boiler level correction per hour—60 lb. (high).
Hot water per hour—87,864 lb.
Correction for superheat—0.28%.
Equivalent dry steam per hour—88,110 lb.
Dry steam per kw.-hour (switchboard)—17.34 lb.
Dry steam per I. H. P.-hour (engine)—11.90 lb.

We give in Fig. 1 an interior view of this great power house and in Fig. 2 a line engraving of an indicator used in the tests, which was arranged to act as a continuous indicator. The design is by W. L. Seabrooke, of the Interborough company. The arrangement consists of two drums *A* and *B* turning freely on spindles *CC*, mounted on the mandrel *D*, which has a reciprocating movement in front of the indicator *E*, the latter being of regular standard design except for the removal of the drum. A strip of paper winding on *A* from *B* passes over the

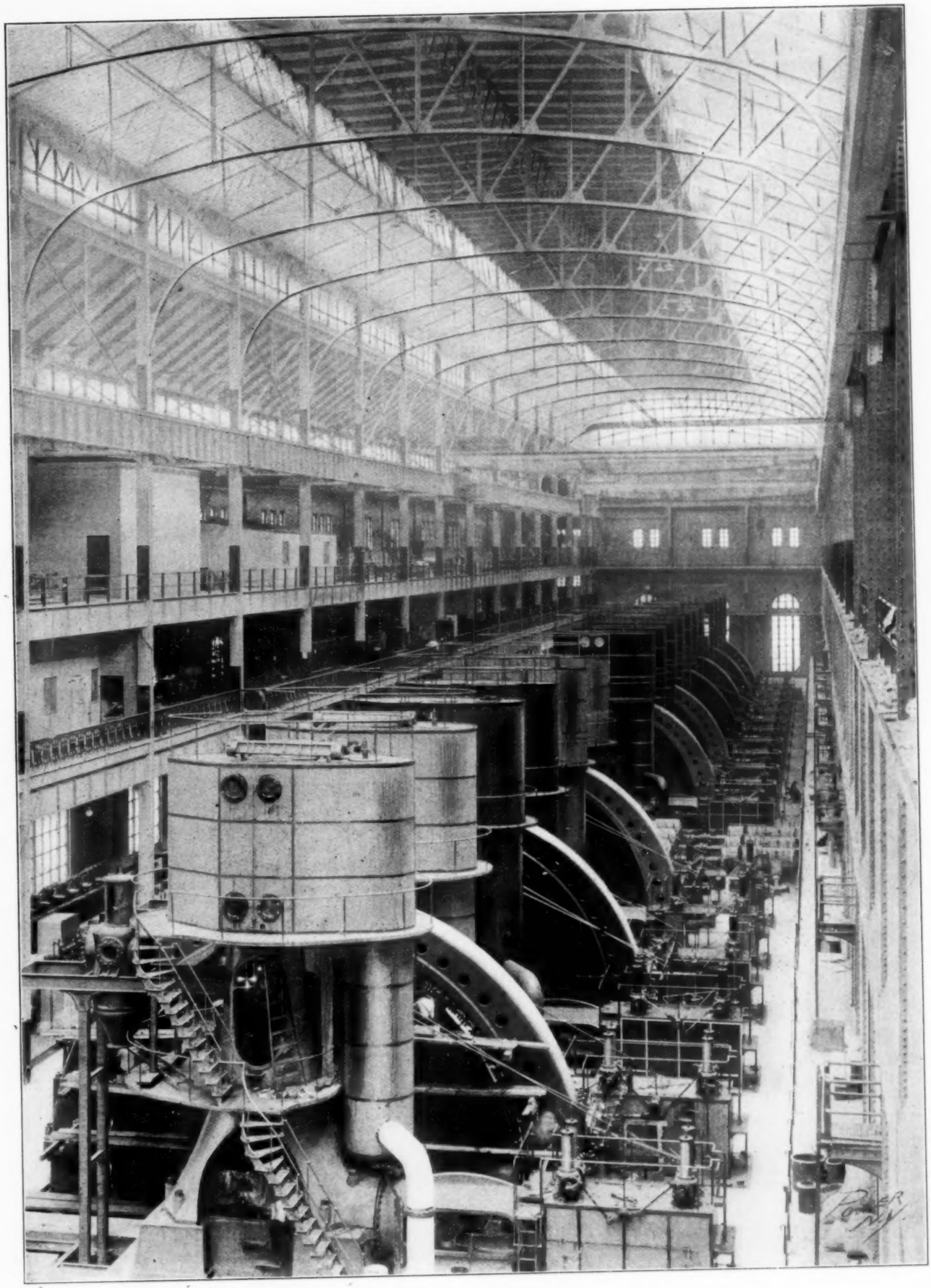


FIG. 1. THE NEW YORK SUBWAY POWER HOUSE.

plate *F*, thus presenting a flat recording surface. As the back pressure line is traced, the ratchet *G* contacts with the toothed wheel under the drum *A*, causing it to rotate a fixed distance. This movement defines the distance between successive cards, and can take place at any point of the stroke desired. As the back pressure line is usually straight, no error is introduced and the cards present the same appearance as if taken singly. The operation is automatic and records a card for each revolution to the extent of the paper supplied by the drum *B*.

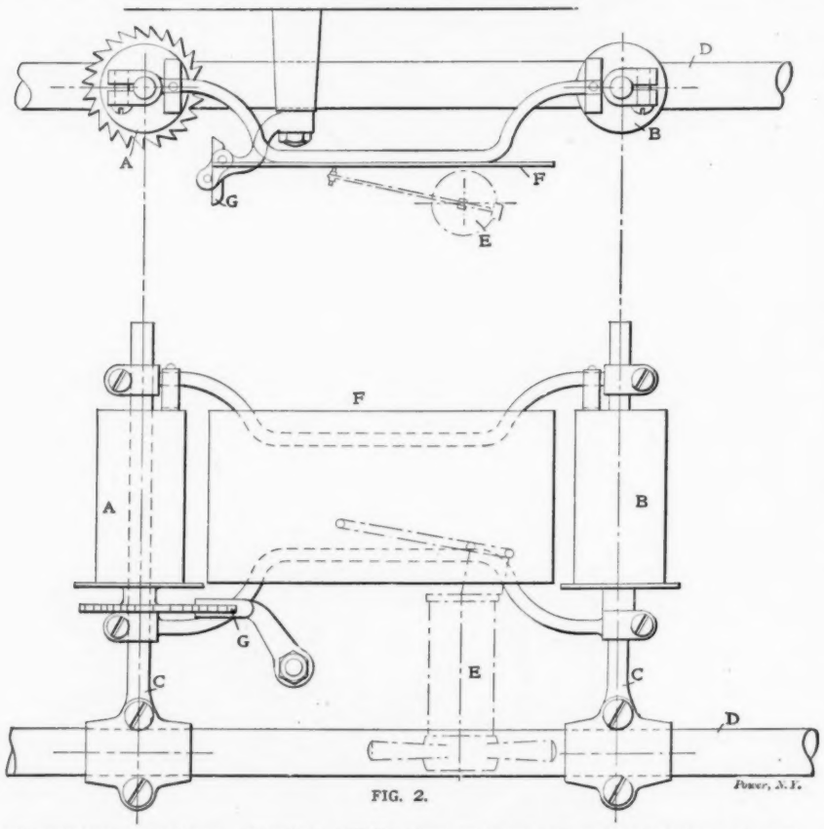


FIG. 2.

CONTINUOUS INDICATOR DIAGRAM DEVICE USED IN TEST OF INTERBOROUGH ENGINES.

The steamer Turbinia is the first and only steamer on the Great American Lakes to be propelled by steam turbine. Last season she ran 203,280 miles. Her coal consumption averaged 2.21 tons per hour under a speed of 23 miles, or 1.48 lb. of coal per indicated horse-power per hour, compared with 1.58 lb. as the best results under like conditions with reciprocating triple-expansion engines. This season her coal consumption has been reduced to 13½ tons per 24 hours as against 15 tons to 16 tons last year.—*The Engineer.*

In sprinkler systems using a shower of water as fire protection, the perforated pipes require from 3 to 8 quarts of water per inch of shower per minute, varying with the pressure and number and size of holes. A pipe 100 inches long requires from 75 to 200 gallons per minute.—*The Engineer.*

The Organization of Railway Shop Forces.*

Much has been written lately on the subject of shop tools; the very interesting discussion brought out by Mr. Barnum's paper in March showing to what extent it was appreciated. In that paper the writer said, if he had to choose between old shops and new tools, or old tools and a modern shop, he would prefer the former, in which conclusion I agreed with him; we carry these suppositions still further, and ask ourselves whether it is better to have new tools and shops with a poor organization of shop forces, or to have a good organizatoin and comparatively old tools and shops. I would prefer the latter and undertake to do more work in a given time than a modern shop with a full complement of new tools and a poor organization.

In looking in a dictionary I find the word "organization" has the following definitions: Act or process of organizing or of forming organs or instruments of action; act of forming or arranging the parts of a compound or complex body in a suitable manner for use or service; suitable dispositions of parts which are to act together in a compound body, etc., so that in speaking of the subject, we will say that it means the act of forming or arranging the parts of a compound or complex body in a suitable manner for use or service.

In getting together a force of men sufficient to man a shop capable of turning out, say, 20 to 50 locomotives a month, (it really doesn't matter how many engines the shop turns out, the building up of an efficient force is very necessary in all cases) the first consideration is to pick a man for the head, whether as general foreman, master mechanic or shop superintendent, who can be implicitly relied on to carry out the plans you formulate for him, and to have such ideas of his own that he will immediately see where delay or friction occurs and apply a remedy. As head of the shop he must have a firm disposition, be prepared to meet emergencies, have the good will of the foremen and men under him, and be tactful so as to be able to straighten out the many little difficulties that are continually arising; it is far better if he has no relatives or friends working for him, as it will save lots of trouble from fancied discrimination, etc. He must be an organizer in the true sense of the word, and every move he makes must be in the direction of increasing his output and decreasing the cost. He should not allow work to be done carelessly or improperly; it takes a long time to build up a reputation for thoroughness, which can be shattered in a few weeks if the work is slighted. I am not a believer in frills and unnecessary ornamentation but do think that it is poor economy to half do a job when most of the expense is incurred in getting to it, and not actually doing it, besides which it engenders loose habits among the foremen and men.

When an engine comes into the shop for repairs, it should be the duty of one or more men to inspect it, and immediately order all of the new material required, and see that it is placed at the machines or benches ready to be worked on when its time comes—don't wait two or three days after the engine arrives, and then find you want something that isn't in stock but ought to be; it will probably mean a delay to the engine going out, which might have been prevented if an earlier inspection had been made.

In dissembling engines each part should be plainly marked so that when wanted again, there will be no difficulty in finding it; the storage of parts that need no repairs is a matter worthy of attention; much material is lost through neglect in storing it away where it cannot readily be found when wanted.

To get engines or work out of a shop, there should be a classification of repairs, and each piece of work done, or each engine passing through the shops, should have a schedule of time, so that all concerned know when it will be necessary for the various parts to be ready. Don't do things haphazard. Set a time limit and work to it, making such improvement

*Paper read before the Western Railway Club, Chicago, by H. T. Bentley, Asst. S. M. P., C. & N. W. Ry.

in tools, ways and means of doing work, etc., that all lost motion is taken up and the results you are after obtained.

The head of the shop should have good men under him as foremen, all of them knowing their business thoroughly and at the same time being able to handle men with consideration, firmness and fair dealing; these combinations are frequently hard to get, but with a large force of men to pick from, the right kind of men can be found, who, by a little training, will meet the above requirements and soon get into his way of doing business.

A good plan to adopt with your foremen is to hold weekly meetings for, say, an hour, and review the work that has been done and that which is ahead of them. Let them tell you how conditions can be improved, what is delaying their work, etc. This getting together is very helpful to the superintendent of shops, as he quickly gets in touch with details, and at such times he can say what results he is after and offer encouragement to get them.

The shop superintendent who is wise, will lend an ear to suggestions made by his foreman or men when they can show a way by which better results can be obtained; once make light or ridicule a suggestion from anyone, however humble in position, and another will not be offered. The mechanic who tells you that a certain casting has more metal on it than is necessary, is helping you to get results and the least you can do is to listen and try to remedy the trouble by asking to have the pattern changed.

The organization of shop forces does not end with the getting together of good foremen and men; it is also necessary to have such a systematic arrangement of accounts and reports that you will not only see that the men are getting the work out promptly, but can tell at a glance how much is being done and what it is costing; without this knowledge you are not able to perfect the organization to its fullest extent; it also enables you to say when asking for new tools, what can be saved in time and money by their introduction, and to know whether it will be cheaper and better to purchase supplies, taps, reamers, etc., or make them in the shops.

The superintendent of motive power who visits his shop frequently and knows all his foremen, can get better results and have the men feel more kindly disposed toward him than the one who does all his visiting by long-distance telephone; a word of encouragement and a suggestion will often bring out latent ideas that otherwise might have lain dormant. It is natural for most men to like their superiors in position to come in personal contact with them and see what they are doing and whether advantageously or not, hence, the advisability of the superintendent of motive power or his assistant making freequent visits to the most important shops and keeping in close touch with the shop superintendents and foremen.

A shop organization is not complete without some means of handling a fire should one occur. A volunteer fire company formed of the men who have been in the service some time and are likely to stay there, should be formed, and a man put at the head who can handle them properly; they should practice at least once in two weeks, familiarizing themselves with fire hydrants, hose, etc. A little encouragement from the officials in charge will keep up enthusiasm, and at a critical time your volunteer company may be in a position to save you thousands of dollars and keep the shops from burning down and throwing themselves and co-workers out of employment. A watchman system which will necessitate the patrolling of the shops at stated intervals, will often be the means of catching an incipient fire and enable it to be put out before getting beyond control. The checking up of watchmen, to know that they are making their rounds at stated intervals, is necessary; it isn't enough to know that they are on the payroll; you must know, through the medium of some check clock system (there are a many good ones on the market) that they have faithfully discharged their duties.

The organization of forces includes among other things the prompt movement of work and tools to the men. What does it profit a superintendent of shops if he has a first-class machine and an up-to-date man handling it, if he has to tie it up several times a day while he goes to get a tool dressed or sharpened, or the supply of material is not on hand when wanted. A sufficient number of tools properly sharpened and dressed should be available at all times, within easy reach of the mechanic, or better still, have a boy who can keep the men supplied.

A shop telephone system will aid in getting out work and will enable foremen to quickly obtain information from each other or from the shop superintendent and *vice versa*, and save endless running about which is a waste of time and energy.

The placing of machine tools so that the minimum amount of handling material takes place will increase the output and save a great deal of disorder and unnecessary work in moving it back and forth; where possible a piece of work should travel from brass foundry, storehouse or blacksmith shop to the various machines so that it never makes a retrograde movement, and when completed, should go direct to its resting place, which should not be around the man or machine finishing it. Always have plenty of unfinished work before your men and remove that which is completed as soon as possible.

Labor-saving devices are a good thing, but they, like other good things, can be carried to extremes. Put an air or electric hoist where it will save delay in handling work, but don't put anything up that will cause a man to wait until someone else has finished with it, when, without it, he would have handled the work himself in a quarter of the time, if no power hoist had been available. Pneumatic tools, hammers, drills, etc., are indispensable in doing work quickly and should be used wherever possible, but 50-ton hoists handling 50-pound loads is a waste of power and should not be allowed. Keep your pneumatic tools in first-class shape and stop all air leaks—it saves the compressor.

The mechanical engineer, while not directly coming under the head of Organization of Shop Forces, is, however, a potent factor in getting results. A bad feeling exists among foremen when castings or forgings come to their machines improperly designed or with more metal on than is necessary. The frequent breakage of parts that could be readily corrected, is something that the mechanical engineer's office is often responsible for, and a man in this position who quickly corrects complaints that are made to him, enables the shop organization to be perfected in a way that few people realize.

The boilermaker foreman finds out that an engine is coming into the shops for a new firebox; his organization would be very weak if he waited until the engine was actually in the shop before some action had been taken looking toward the building of a new firebox, so that as soon as the old one had been removed, the new one would be ready for application. The same with engines requiring new side or flue sheets; the material should be on hand before it is needed, or much precious time is lost and the whole machine is temporarily disorganized.

The blacksmith shop generally is not a place that looks neat and tidy; there are, however, some notable exceptions to the rule, and orderliness pays there just as much as anywhere else. The turning out of duplicate work by machine instead of by hand makes a big reduction in cost, and the blacksmith foreman who can organize his work and men so that he is always in the van instead of the rear, is a valuable addition to the shop organization.

The tank shop, tin shop, paint shop, brass and iron foundries, etc., deserve a word. It is not necessary for me to go into details about these shops, but they all play their parts in getting results; it is of no avail if the machine and erecting shop have the engines finished on time if they have to lie around two or three days waiting for the tender. All must work harmoniously or the results obtained will be unsatisfactory.

The power plant is an important factor in the smooth running of a shop. En-

gines that are continually falling down, or are too small to carry the load, and boilers that do not furnish enough steam, especially when the weather gets cold, are a trial and tribulation to the man who is trying to get there. Relay engines and boilers cost money but often save shutting up shop when it can least be spared.

Apprentices should be given opportunities to learn their business thoroughly, as we depend upon them to make our future mechanics; if they are looked upon and treated as necessary evils, we may expect indifference and indolence from them; but if treated properly, and shown how to do their work efficiently and quickly, they will in most cases turn out desirable men to keep in the shops. In our home life we endeavor to educate our children so they will grow up and be a credit to us and to themselves; then why, in our business life, should we not do the same with the young men who come to us for mechanical training? Special apprentices, who have graduated from a technical college, are invaluable if made of the right kind of stuff. In a large establishment conditions are often arising where some special information has to be obtained, which necessitates mechanical training and a certain amount of technical knowledge to properly work up the data. In this field special apprentices can be used to advantage, and later, when they have completed their term of apprenticeship, if competent, they can be used in higher positions to advantage.

This is the age of specialists and in hiring men you will find some who are first-rate mechanics in one line and not much good in another. The good all-around mechanics, like the old family physician, are disappearing from our midst and instead, we get the air brake man, machine hand, the valve setter, the man who is handy at lining up guides, etc. Find out what your man's strong forte is and use him at it wherever possible; in a large shop this can be done to advantage with a corresponding increase in your output.

Always be on the outlook for promising timber in the shape of young, energetic and progressive men and encourage them, so that when in want of a foreman or master mechanic you will know where to find one. Many a good man has been lost to the profession through lack of encouragement. Nothing stimulates a man so much as to know that his work is appreciated. Have we not all felt animated and enthused to do better when we have received a word of approval and praise? Some of us are prone to find fault, and we do that unsparingly, but how often do we give credit where it is due? Most of us, I am afraid, take it as a matter of course, and let it go at that; try the other plan occasionally and see what results you will get. Don't have too many rules, bulletins and notices; they take up the men's time reading and discussing them. Only make such rules that you know can and should be carried out, and then see that they are lived up to.

The motive power department organization can be demoralized and nearly put out of business if it is not backed up by the storekeeping and accounting departments. The prompt furnishing of material in sufficient quantities to keep machines going long enough to perform the work economically is a matter that must have attention, otherwise the cost will immediately go up. The setting up of some machines often takes longer than to do the work, if furnished in small amounts, and a direct loss to the company takes place. The furnishing of cost sheets within reasonable time after the work is done is very helpful in detecting increased or decreased cost and applying the remedy in the former case before the matter gets old. In some shops messengers are used to deliver material and they are great time savers when used in connection with a shop telephone system. The ordering of material is done by 'phone to storehouse and deliveries are made from there by boys or men, thus obviating the necessities of high-priced mechanics going back and forth doing work that is just as well performed by cheaper labor.

Nothing looks so bad in a shop as material, whether usable or scrap, being allowed to lie around indiscriminately—a man is frequently what his surroundings are; if neat and clean he, unconsciously perhaps, becomes so, but where dirty and untidy he would make it more so by throwing things down that he otherwise would be ashamed to do, if a proper example had been set him in orderliness. Some people think it doesn't pay, but try both methods and you will quickly find that a dirty shop is the most expensive to handle and most unsatisfactory for all concerned. Have distinctive marks on scrap and usable material, and see that it goes where it belongs when once picked up—it is cheaper than to set it down and pick it up later on.

There are numerous other things that can be done to perfect a shop organization. I have simply given a few ideas which can be amplified according to requirements. In closing I would simply sum up the whole by saying that the following requisites are necessary to get the best results:

A good man at the head of the shop.
Good foremen under him.
The education of foremen and men.
Proper control of men by foremen.
Punctuality.
Orderliness.
System.
Harmony.
Prompt movement of material to and from the various departments.
A good system of handling tools.
The use of templets and jigs wherever possible.
Absolutely fair treatment of foremen and men.

There was a long discussion upon this paper, very commendatory in tone; from it we take a few extracts, as follows:—

M. K. Barnum (C., B. & Q. Railroad): A good organization is absolutely necessary to get good results, whether a shop be large or small, but the larger the shop the greater are the opportunities for a poor organization to become conspicuous and wasteful. The larger the shop the more difficult it is to find the right kind of superintendent and foremen to manage it, and the more they can earn for a railroad company, their possibilities are greater in proportion to the amount of work done.

One of the most important points to my mind which Mr. Bentley makes in his paper, is where he insists upon work being well done, and it frequently devolves upon a shop superintendent to decide where to draw the line and to say how much work shall and what shall not be done on certain parts of cars or locomotives that come to the shop for repairs; and he can save his company large sums of money by making wise decisions on what is good enough to go and what shall be repaired.

I have seen instances illustrating what the author of the paper refers to where he speaks about ridiculing suggestions. I remember one case where an official was always asking the opinion of everybody he met, and while he occasionally adopted a suggestion he sometimes ridiculed excellent ideas derived from long experience, with the result that after a time many men ceased to give him suggestions and simply said as little as they must to be respectful. That man, by so doing, shut himself off from much valuable information.

Very few railroad companies throughout the country know how much money they are wasting in power plants. There are a few railroad shops with up-to-date power plants, but I will venture to say that nine-tenths of them are behind the times and very wasteful. Some time ago I had occasion to look over a power plant with a view to determining what improvements were necessary and found that the waste in fuel and labor alone amounted to over 10 per cent. on $180,000 every year. $180,000 would build a strictly up-to-date power plant for a large shop.

A. E. Manchester (C., M. & St. P. Railway): There is one point in connection with the paper, where it says: "The superintendent of motive power who visits his shop frequently and knows all his foremen can get better results and have the men feel more kindly disposed toward him than the one who does all his visiting by long-distance telephone." I have always felt that there was something in that proposition and that the superintendent of motive power, the mechanical engineer's

office, the drafting office and all of that portion of the organization could give its best results when they were located at the principal shops. That is not the practice as I know it to-day with a great many of the large organizations, but I can't help but feel that that portion of the paper has some value; it is a fact that the superintendent of motive power can and does, when he is so located, see that the work is being done almost daily, and is in closer touch with his entire organization from the top to the bottom than he can possibly be if his office opens into the general manager's office at the headquarters.

The mechanical engineer and his staff can, I believe, do better work when they are right where the work is being done; where they can spend at least some portion of their time reviewing the scrap pile, because it is a better history, it is a better report on the character of the mechanical engineering work and the mechanical work that is being done in the shops than any other method that is known to men.

That feature in which the paper refers to the foremen and the heads of the department getting together frequently and conferring is one of the strongest features in connection with an organization, and the farther down the line we go and the more men we can take into our confidence and the more we can ask or get the assistance of in telling us where we can or ought to do better, the better off we will be and the better organization we will have.

W. E. Symons: In reference to the blacksmith and boiler shop, the question of the care of tools has not been dwelt upon either by the author of the paper or any of the speakers. I mean by this, some systematic method of keeping all tools and appliances used by workmen, particularly those used by boilermakers, blacksmiths, machinists and car men in a good, safe condition, free from defects that might contribute to personal injuries. The boilermakers' and blacksmiths' tools, such as heavy cutting-off chisels, swages, flatters, formers, and even the small hand tools such as cape and flat chisels, calking and fullering tools, the faces of which receive the impact or blow of the hammer, thus causing slivers or scales to form, which, if not removed by being repaired at the proper time, usually fly in some workman's eye resulting in personal injury, and in many cases this is followed by a damage suit against the company, ranging from five to fifteen thousand dollars, depending upon the locality in which the road lies where the accident occurs. I have found by personal experience that it is not a difficult matter to have all tools and appliances of this kind kept in a very good condition by personally talking to the master mechanic, foreman and workmen, and creating a sentiment against defective tools or careless habits in their use. In most instances all tools of this kind can be kept in good physical and safe conditions by the employees who use them, without detracting to any appreciable extent from their customary and reasonable output of work. In fact, as a rule, men can do enough more work with good tools in proper condition than would more than offset the time occupied in repairing them, and thus almost entirely eliminate the question of personal injury.

Mr. Bentley (written discussion in closing): Mr. Emerson is right in saying that I missed one of the most important points in the final summing up, when I did not again mention the importance of getting accurately and quickly the cost of doing work.

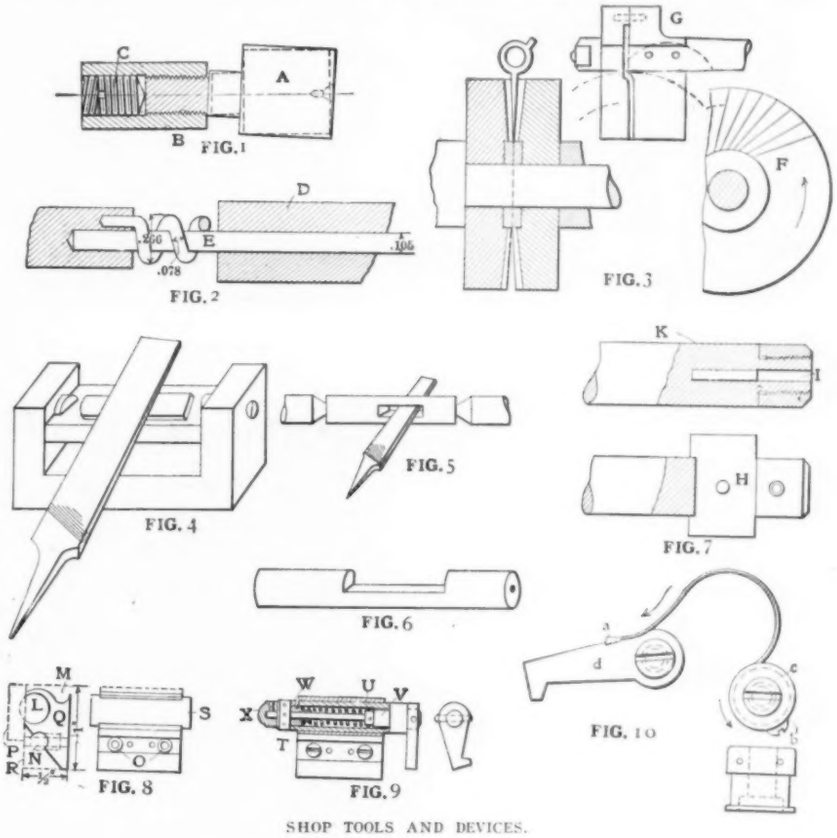
Referring to Mr. Symons' remarks, I spoke about a shop capable of turning out from twenty to fifty engines a month, and the use of a local telephone system in such a shop; we have an automatic exchange which has been invaluable to us since its installation. I believe, however, in a smaller shop than ours, such a system would be a paying investment; the facility with which you can transact business only wants to be seen once to be appreciated.

Twelve months ago the number of motor omnibuses running in London was twenty. It has now risen to 230, and great additions to this total will shortly be effected. The orders have been given, but delay arises in getting delivery.—*The Engineer.*

Shop Tools and Devices.

BY F. J. LE CARD.

For rectifying work which has been threaded with a solid die and which has as a result a thread not true with the body, as exaggerated at *A* Fig. 1, I use a piece *B* in a spring chuck in a bench lathe, or other lathe, and hold the piece by the thread while turning and facing (as indicated by the dotted lines) to true the job with the screw. I carry pieces like *B* for screws in common use, for various purposes as I have shown in other articles. The thread and outside run true, and the lock-screw *C* bearing on *A* with a point, holds the screw by the sides of the threads, a center being obtained also if needed.



SHOP TOOLS AND DEVICES.

A method of coiling heavy spring wire on a light arbor is illustrated in Fig. 2. The piece *D* is held in a chuck or collet in the tail stock of the lathe, and drawn back as the spring is coiled, thus supporting the arbor *E* at the bend of the wire. I recently wound in this way piano-wire springs of the dimensions given on the sketch.

Fig. 3 shows how a pair of milling cutters can shave down the sides of a thin tapering piece, such as a watch regulator, by being made to work against each other, and give a draw cut. The teeth as shown at *F* being on a tangent, strike the work gradually and two or three at once. *G* shows the manner of clamping the work.

Figs. 4 and 5 are old-time devices for rocker filing such pieces as are shown in

these two sketches and in Fig. 6. Flat filing is easily done in this way.

The holder in Fig. 7 is for turning flat work like *H*, say a counter bore or reamer blade. The only novelty in the device is the slot *I*, sawed in from the end, which obviates the difficulty of filing out a slot for the blade, the nut *K* making a solid job. By slotting two pieces like *H* in the center half way across, and interlocking them, they can be inserted in right angle slots where the size of the arbor will admit, and so form a four-lip reamer, or a tap all fluted.

By the way, a tap can be cut readily in a lathe, and cut without tearing, by cutting it somewhere near size first, then milling the flutes, annealing the steel, and cutting the thread to size last. This helps in the hardening too, as it takes the warp out of the steel.

Figs. 8 and 9 cover several points of interest. The first illustrates how a very neat pawl-bracket was made in a bench lathe and mostly with twist drills. The material was mild steel 1x½-inch sawed off in the power hack-saw. The holes *L, M, N, O, O*, were drilled, as shown by dotted lines. The extension *P* was clamped to *Q* to facilitate drilling L. The corner *R* was sawed off by hand. The sleeve *S* was soldered into *L* and a file completed the piece. Fig. 9 shows the pawl mechanism, which is lively and has a great range of adjustment. The spiral spring is soldered at the ends to collars *T* and *U*, the latter locking the arbor for the pawl at *V*. By turning *T* by the pin-holes to get the tension on the spring, and locking it with the screw *W*, entering depressions in *T*, the pawl is given any pressure needed. *X* is merely a retaining collar.

In Fig. 10 is shown another adjustable pawl spring, a flat one with edges turned down at *a* to keep it in place. By turning the stud *b* and securing it with the screw *c*, the spring is moved in the direction shown by the arrow to increase the tension. The spring as constructed is almost unbreakable.

This pawl was used in an index with eight divisions. It carried the index plate two places, then a retaining pawl held the index while the pawl *d* moved back a notch. Then the retaining pawl came out and the pawl *d* drew the index back one space; thus the pawl moved two spaces each time and still gave eight divisions. The spring as arranged was easily adjusted to give the pawl the right pressure on the index to draw it back while overcoming the friction of a thin cup-spring against it.

Some of this matter may come in handy in model and experimental work, or in machine construction.

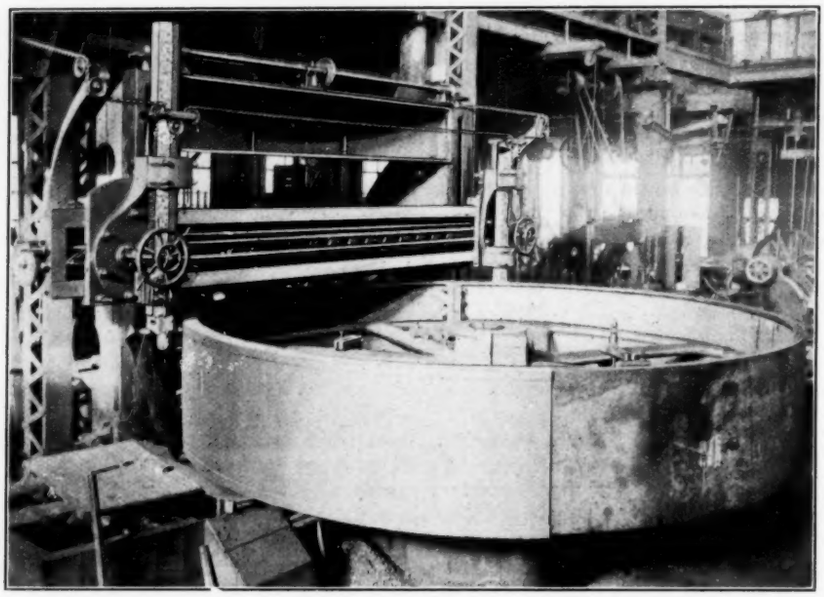


FIG. 1. TURNING THE NEW HALF WHEEL.

Making Half a Band-Wheel.

An interesting job was recently done in the shops of the H. W. Caldwell & Son Company, Chicago. The job was the casting and finishing of one-half of a large band-wheel. The original wheel had been made by another concern, but while being placed in position on the crank-shaft of the engine, one half fell into the pit and was broken. It is not usual for a foundry to cast a half to match another half made by another foundry, of whose cupola mixture or practice nothing is known. However, as the order for the new half was given them, they accepted it, and analyzed the metal in the broken half, figuring out a mixture to give the same shrinkage. The new half was molded in loam, cored out at the hub and arms in the ordinary way, and poured.

After cleaning, chipping, drilling and facing, the old and the new halves were bolted together and put on a 20-foot boring mill. After part of a cut had been taken, the photograph was obtained of which Fig. 1 is a reproduction, the lighter being the new half. After turning, the face was finished, and the wheel arranged for boring the hub as shown in Fig. 2.

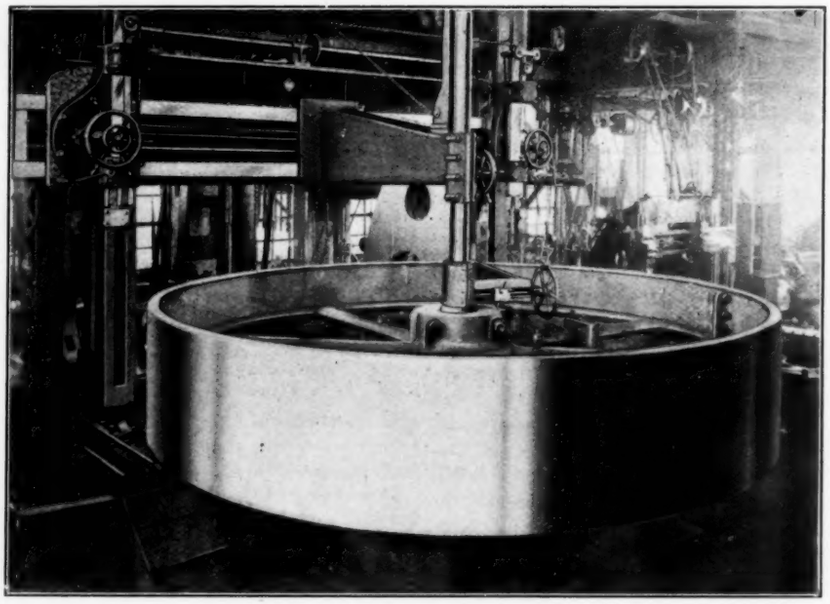


FIG. 2. READY FOR BORING.

The finished wheel is 18 feet in diameter by 42 inches face, the bore is 15 inches and the weight 27,806 lb. The remarkable part of the job, which not only shows that the work was well done but that the iron in the old wheel was closely matched, is that the finished wheel was found to be only 94 lb. out of balance, the new half being the lighter of the two.

Studies in Inventive Problems—XV.

Proposed by Leicester Allen and Solved by Various Readers.

A solution of Problem V has been received from C. W. Pitman, Philadelphia, Penn. I do not reproduce his neatly executed drawing or quote his description, because they are substantially identical in principle and construction with the solution of William C. Whaley, presented at page 19, Vol. 29, to wit, the variable rotary motion is effected by elliptical gears and the vertical motion is obtained by the use of a cam. Mr. Pitman must, however, be credited with a correct solution.

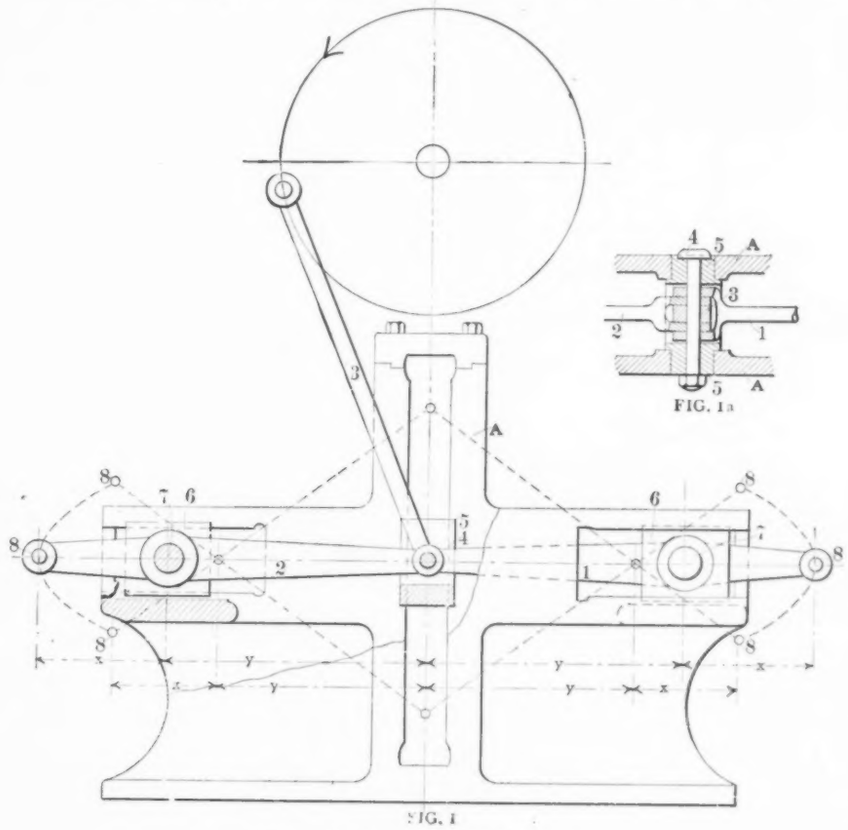


FIG. 1

SOLUTION NO. 2 TO PROBLEM VI.

FIG. 1a

The number of solutions and attempted solutions of Problem VI is quite small. It appears that some of those who have applied themselves to the solution of this problem, have interpolated into it conditions which the statement of the problem does not contain. For example, some have thought that a harmonic motion of the rock-levers was an essential element. Nothing in the statement of the problem implies such a condition; but students of the problem, applying the laws of composition of forces, will have preceived that whether the motion of the levers be harmonic, a motion at a constant velocity or an intermittent motion, the result demanded by the problem cannot be obtained except when the force is at any instant applied to both the levers simultaneously at the same angle each to each. I see no way in which this can be done under the restrictions of the problem, except by applying the force simultaneously to both levers, at a point on each equi-distant from the fulcrums and in a direction tangent to both the curves simultaneously described by the points at any instant. A line of direction which will satisfy these conditions is one making a right angle with a line joining the fulcrums, every point of which line is equidistant from the fulcrums. Correct solutions of the problem must embody such a geometrical construction.

The demonstration of laws governing composition and resolutions of forces, is strictly geometrical. It was the purpose of the problem to try the experiment of stating a simple problem in terms which demand some acquaintance with these laws, and let readers deal with it as they might.

PROBLEM VI., SOLUTION NO 2. FIGS. 1 AND 1*a*.

WM. WHALEY, KNOXVILLE, TENN.

Mr. Whaley uses three slides. His description follows, and as will be seen, accords with the above statement of geometrical construction. The line of application of the force to the levers is at any point equidistant from the fulcrums and is tangent to the curve described by the point of application, which curve, in this case, owing to the movable fulcra, is of infinite radius, thus becoming a finite straight line over which the center of pin 4 travels.

"In the figures 1 and 2 are the rock levers having pivotal bearings 7 in sliding blocks 6-6, and connected on power end by a pin 4 to each other, to the pitman 3, and crosshead 5. *A* is the frame carrying the guides for crosshead and sliding block. The connection to the pitman is shown in Fig. 1-a. In operation the pitman, driven by crank, reciprocates the crosshead and inner ends of 1 and 2 up and down in the vertical guide-way in *A*. The outer or resistance arms of 1 and 2 oscillate up and down, the dotted line showing path of movement of point 8. The fulcrums or pivots of 1 and 2 in blocks 6,6 slide backward and forward, always in the same plane and in the same straight line. The leverage of resistance arm at any point is equal to distance *x* between perpendiculars dropped from the centers to center line of pivots; likewise the leverage of the power arm is equal to the distance *y* from point 7 to center of vertical slide way, and these distances are always proportional in any position of the levers."

Mr. Whaley makes a mild criticism of solution No. 4, Problem V (Mr. Hayden), page 18, Vol. 29, as follows:

"I notice that in Problem V, solution number 4, Fig. 3, the statement occurs that with a pair of equal elliptic gears the variation of speed from minimum to maximum and back again occurs twice in each revolution of the gears, which statement I believe to be erroneous, the elliptical gears making but one cycle per revolution, as described in my solution of this problem. Also in the diagram Fig. 3, the elliptic gears are shown pivoted at the centers of the gears instead of the foci. Your own solution is much superior to elliptic gears in any form."

My own solution of Problem VI being substantially like that of Mr. Whaley, No. 2, above presented, no interest will be added to this article by presenting it. I shall therefore here resume the presentation of the solutions of Problem VII. I may here also say that my own solution of Problem VII almost exactly corresponds with one of those I have received, varying only in unessential details, as will be noted in due course.

PROBLEM VII, SOLUTION NO. 3, FIGS. 2, 2*a*, AND 2*b*. ROBERT P. DEANE, HOLYOKE, MASS.

Note that in Fig. 2, the table is represented as transparent to make the drawing clearer. Mr. Deane thus describes his design:

"Fig. 2-a is a partly sectional side elevation, Fig. 2 a plan view and Fig. 2-b a detail.

"*A* represents the path the cutter is to travel in and *B* the cutter and spindle which are revolved in block *D* by means of pulley *C*. This block is caused to travel from *E* to *F* by means of a screw *G* which is revolved by a pinion *H* which meshes into a larger gear *I*, which in turn meshes into a crown gear, *J*, mounted on the under side of the table *X*. The circular casting *O*, which carries this mechanism is suspended so that it may revolve in a split ring *K*, which has foot pieces, *L*, L^1, L^2, L^3, bolted to the table. Two crown gears *M* and *N*, one bolted to the revolving casting *O* and the other keyed to shaft *P*, are connected by gear *Q*; hence, as shaft *P* is revolved, *O* is revolved by gears *N Q M*. As *O* revolves, gear *I*, meshing into the stationary gear *J*, revolves gear *H* and screw *G*, thus moving the block *D* from *E* to *F*, or *F* to *E*, according to the direction that *O* revolves. Shaft *P* is revolved by means of two pulleys, *R* and R^1, one driven with an open and one with a crossed belt, which pulleys are connected to shaft *P* through clutch *S*. The clutch is operated through connection *T* by bell crank *U* which has a projection *V* extending far enough toward *O* to engage pin *W* (which is driven into *O*) throwing out the clutch and stopping the feed. When a new board is in position it may be started with the hand in the opposite direction, provided the wood will cut properly feeding either way.

"Fig. 2-*b* shows a binder for keeping the belt on *C* tight in any position. In this figure *d* is the driving shaft and *B* and B^1 two idlers connected to lever *D*, which swings on a fulcrum *E* with a heavy spring *F*, keeping an even tension on the belt."

I have no doubt a very good machine can be designed on the lines indicated by Mr. Deane, who seems to perceive the full scope of the problem. The same remark applies also to the following solution:

PROBLEM VII, SOLUTION NO. 4. FIGS. 3, 3*a*, 3*b*, AND 3*c*. J. MELANCON, AMITE, LA.

"In this solution the cutter spindle moves with uniform speed from a point over the center of the table to a point over its circumference, while the circular table, holding the work, revolves, carrying the block of wood to be operated upon along with it. The figures show a crude machine embodying these features:

"Fig. 3 is a plan, and Fig. 3-*a* is a side elevation of the machine with section through the center of the carriage *H*. Fig. 3-*b* also, is a longitudinal section through the center of the carriage, showing the opposite side. Fig. 3-*c* is a cross-sectional view of the carriage.

"If pulley *A*, which drives the machine,

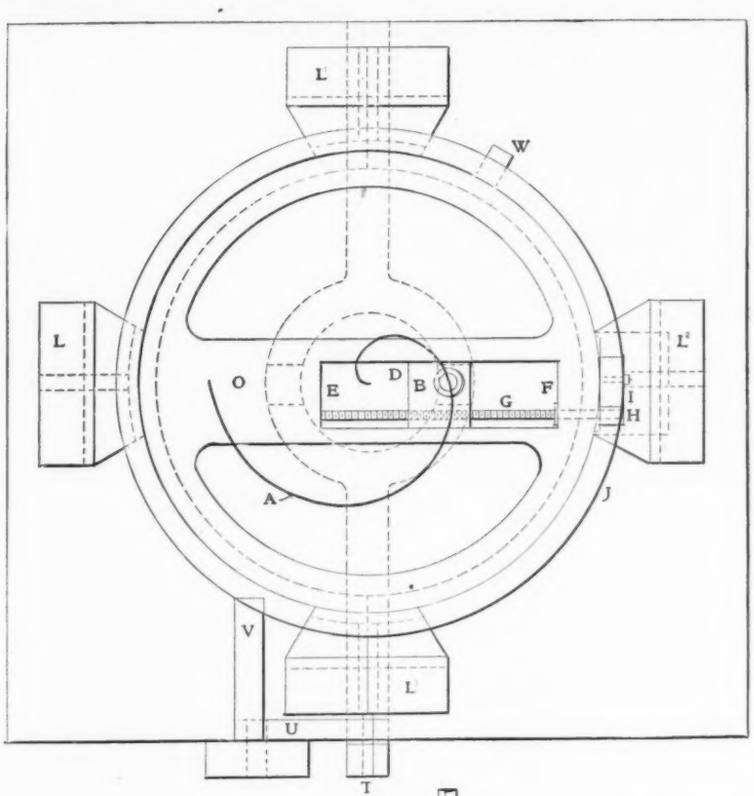


FIG. 2

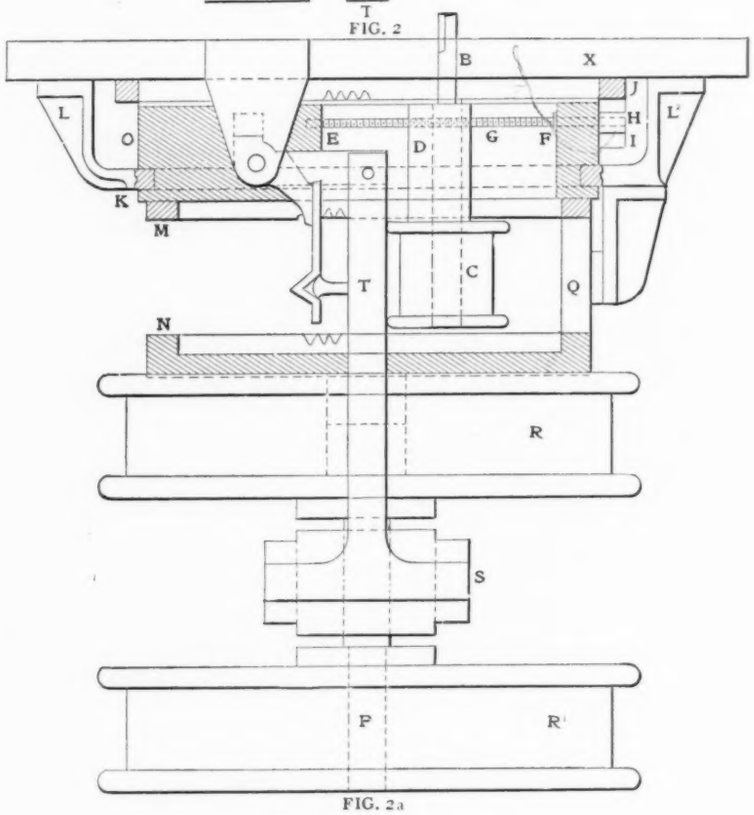


FIG. 2a

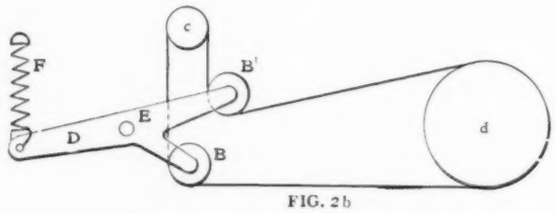


FIG. 2b

SOLUTION NO. 3 TO PROBLEM VII.

revolves at, say 300 r.p.m., this speed is altered by means of gearing in the base of the machine and in gearing head *N* so as to give the various moving parts the following numbers of revolution: Table *B* makes one r.p.m.; shaft *C*, which drives cutter spindle, say, 600 r.p.m., and shafts *D* and *E*, which move the carriage away from and toward the center of the table respectively 16 r.p.m. Shaft *C* drives cutter spindle *F* through gears *G* and *G*¹, the former having a feather fitting in a spline cut in shaft *C*. *G*¹ has a feather fitting into a spline cut into cutter spindle *F*; thus the latter may move vertically independently of *G*, but is forced to revolve with it. The forward movement of the carriage is obtained from threaded shaft *D*, and the backward movement from threaded shaft *E* by means of block *I*, which has its top and bottom surfaces threaded so as to form half nuts or slightly less. These threads are 30 deg. V-threads and engage alternately with similar threads on *D* and *E*. *P* is a stationary shaft which simply serves to sustain part of the weight of the carriage and its contents. Spring *L* is omitted in Fig. 3-*c* so as to show block *I* more clearly. The position shown in all these views is the same.

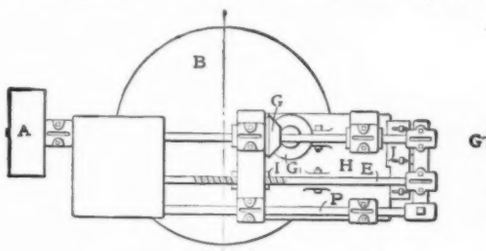


FIG. 3

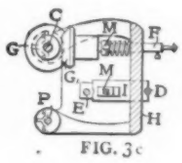


FIG. 3c

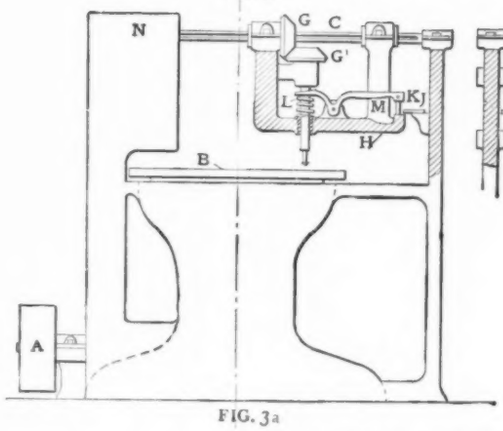


FIG. 3a

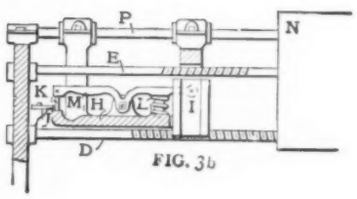


FIG. 3b

SOLUTION NO. 4 TO PROBLEM VII.

"It will be observed by reference to Figs. 3-*b* and 3-*c* that block *I* is engaged with shaft *D*. The carriage *H* is therefore on its outward stroke and is near the outer end of this stroke. Consider Fig. 3-*a*. A slight movement of the carriage away from the center of the table will cause plate *J* to trip member K, thus allowing spring *L* to lift the cutter spindle clear of the work; hence the cutting action upon the block of wood ceases at this point, and the number of threads on *E* and speed of the same must be so proportioned to the rotary speed of the table and the tripping plate *J* so adjusted that this raising of the cutter spindle takes place when the table has made just one revolution from the time that the carriage started on its outward stroke. Further slight outward movement and *J* trips *K*, Fig. 3-*b*, allowing spring *L* to force *I* upward, engaging the threads on its upper surface with those on shaft *E* and causing the carriage to start backward. The threads on this shaft and corresponding half nut are of much coarser pitch than those on shaft *D*, giving a comparatively quick return motion. During the return stroke of the carriage the operator takes out the block of wood which has just been worked upon, puts another in its place and clamps it solidly to the table. When the carriage has arrived at such a point that the cutter spindle is over the center of the table block *I* runs off the end of the threads on shaft *E* and the carriage remains stationary until the operator has finished adjusting a fresh block upon table. To operate upon this block the attendant first raises lever *M*, Fig. 3-*a*, until member *K* rests upon the top of the carriage flange as shown in the figure. This lowers the cutter into the block of wood; lever *M*, Fig. 3-*b* is raised, until member *K*¹ rests upon the top of the carriage flange, as shown, which lowers block *I*, bringing the threads upon its lower surface into contact with threads on shaft *D*, which starts the carriage on its outer stroke. The action of the machine is then automatic until the carriage again reaches the position in which the cutter spindle is over the center of the table. For working upon blocks of different thicknesses the table *B* might be given a vertical adjustment, while for different curves the speed of shaft *D* might be changed by manipulating the gearing inside of head *N* just as the speed of an engine lathe lead screw is changed. Of course it would also be necessary to adjust the tripping plate *J* to trip *K* and *K*¹ at the desired point."

PROBLEM VII. SOLUTION NO. 5, FIG. 4. OTTO J. LEWIS, INDIANAPOLIS, IND.

We have here what may be worked out in detail into a fine design for the purpose specified in the problem. It is differentiated from any other of the solutions received. I should say, from the character of this solution, that it is evidently from the drawing board of a designer familiar with, if not practiced in, the design of wood-working machines. It corresponds so nearly with my own solution of the problem that it will be entirely needless to take up space with my drawing and description, which I therefore shall omit. Mr. Lewis supplies the following description:

"*A* is a friction disk, driven by bevel gears as shown. *B* is the driving pulley, driven by belt from a countershaft having a reversing clutch. *E* is a drum which carries a circular rack on its lower edge and is rotated by pinion *F*, which meshes with the rack. The drum *E* carries a slide *G*, which supports the vertical spindle *H*. The slide *G* is moved across the drum by the screw *J*, operated by the pinion *K* meshing in the stationary circular rack *L*. The spindle *H* is driven by bevel gears or friction cones through the splined shaft *M* which is driven by the driving nut *D*, to which is attached the small friction disk *C*, driven by the large disk *A*. The driving nut is carried by a bracket attached to the drum *E*; hence the speed of the vertical spindle is constant for all positions of the slide. Since the forward movement of the spindle is proportional to the angular movement of the drum, the curve described by the axle of the spindle will be a spiral of Archimedes. A right-hand spiral will require a right-hand screw *J* inside of a left, as shown in the drawing.

"No attempt has been made to detail parts not required by the solution. However, in a machine of this kind it would be necessary to stop the slide automatically when the spindle reached the central point, to reverse the drum without reversing or stopping the driving spindle and to quickly raise and lower the table to any position desired. To accomplish the first, the pinion *K* should drive the screw by means of a clutch which will release at the central position of the spindle when the drum is reversed. The drum could be reversed by means of

loose pulleys and clutches on the shaft *N*. The table could be raised and lowered by rack and pinion, or in several other simple ways.

"A more practical machine could be made by having the table itself revolve. This would leave only the forward movement for the spindle slide, and not only would the drive be reduced to one splined shaft and bevel gears, but change gears

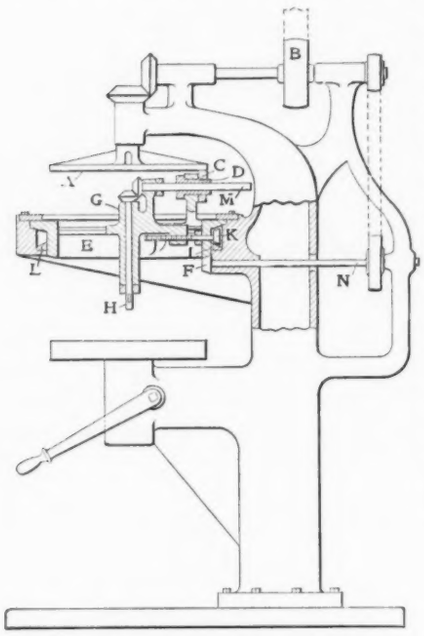


FIG. 4. SOLUTION NO. 5 TO PROBLEM VII.

could be placed between the screw operating the spindle slide and the pinion shaft driving the table, so that a large variety of spirals could be cut. The problem of automatic stops and quick return could be more easily solved, and no change in the height of the table would be necessary as the spindle itself could be raised and lowered by means of a hand lever, which is not possible in the present case.

"In the metal-working line, a milling machine, fitted with a vertical head and self-feeding rotary attachment, will cut such a spiral. The geared feed engine lathe cuts a similar spiral when facing."

Some solutions of this problem yet remain to be considered.

In concluding this number of the series, I desire to make some remarks on attempted solutions of Problem VIII, and will present one of these in Fig. 5, thereby illustrating a point apparently overlooked by the majority of those from whom these defective solutions have been received. As these solutions are for the most part diagrammatic, involving very little drawing, and the accompanying descriptions are brief, I shall hope that, after the defect spoken of has been pointed out, these may be replaced by more complete solutions.

The problem demanded that a piston of an ordinary steam engine having a 14-inch stroke, *making full stroke and cutting off steam at half-stroke,* should drive a crank of 12 inches throw (six inches radius). The following from W. G. Tomlinson, of Lima, Ohio, came to hand without any drawing, either diagrammatic or otherwise:

"At page 22 of the AMERICAN MACHINIST I note the problem VIII, in regard to utilizing a 14-inch cylinder on a 12-inch crank, which changes can be in numerous ways—in theory at any rate—at the crank end or cross-head, although it seems to me that a very simple, practical and effective method would be to place a 1-inch plate in each end of the cylinder, made secure to the heads by studs, taking care to recess the plate to allow steam to enter as freely as without the plates."

It is quite incomprehensible to me that such an answer as this could be considered by anyone as a solution of the problem set forth. It sums up to this:

To drive a crank having a twelve-inch throw by a piston having a 14-inch stroke, making its full stroke and cutting off at half stroke, reduce the stroke of the piston to 12 inches, and pad the cylinder heads, involving the absurdity that the full stroke can be shortened and still remain *the specified full stroke.* I cannot conceive that Mr. Tomlinson could have read carefully the problem as it was stated.

In Fig. 5, I present an imperfect solution contributed by R. P. Deane, of Holyoke, Mass.

"In the sketch, *A* represents the cylinder of a steam engine with 14-inch stroke. The center of the crankshaft *D* is set on a different plane from the center of the piston rod *B*. The position of *D* may be determined as follows: With the outer end of the piston rod at one end of the stroke *B* as center, strike a circle with radius equal to the length of the connecting rod, and from point *G* at the other end of the stroke strike a circle with same radius. As the throw of the crank is to be 12 inches, strike circle with six inches radius, so that it will be tangent to both circles. The dead center will be at *E* and *F*, or at points where straight lines from *B* and *G* running through *D* intersect the circle of the crank throw. It is evident that the distance between *E* and *F* in the direction of the arrow, is less than from *F* to *E*, so that the piston would have to travel faster on the back stroke than on the forward, but this difficulty might be overcome by making the steam ports of unequal sizes, i. e., the forward one larger. I think this would work satisfactorily on a gas or other single acting engine, but might not work as smoothly on a double acting engine.

"It seems to me that fulcrum *E* might be attached to a crosshead running in guides parallel with a line *H D*, *H* being half way between *B* and *G*. Then from point *E* a connecting rod might connect point *E* with a crank on line *H D*, thus making the dead centers come opposite each other."

Now when the piston rod, cross-head pin and crank-pin of an engine, when the crank-pin is on a dead center, are in line, we need no demonstration that a cut-off at half-stroke is possible, this cut-off being a familiar problem solved innumerable times in steam engineering practice. It has, I believe, never been shown that this is possible when the parts named do not line on the dead points. Therefore, as a cut-off at half-stroke is demanded by the terms of the problem, it is incumbent upon all who claim to have solved the problem by a construction analogous to that of Mr. Deane, to show that such a cut-off is compatible with such construction. And, though I stated in the enunciation that the valve motion need not be laid out or described, *unless found essential to explaining the mode of converting the piston stroke specified into the motion specified,* I, of course, meant that *all the conditions including that of the cut-off must be fulfilled.* I hope those who have offered solutions based on the placing the crank center out of line with the axis of the piston rod, will revise their work, and, if possible, show the compatibility of the cut-off specified with the relative position of the crank center shown. If this can be demonstrated without a layout of the valve motion, as it can be in more than one way of solving the problem, such layout may be omitted, but the condition that cut-off must be at half-stroke must not slip out of sight.

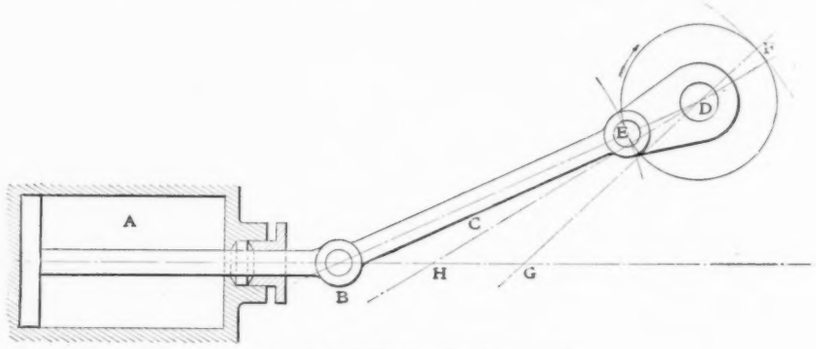


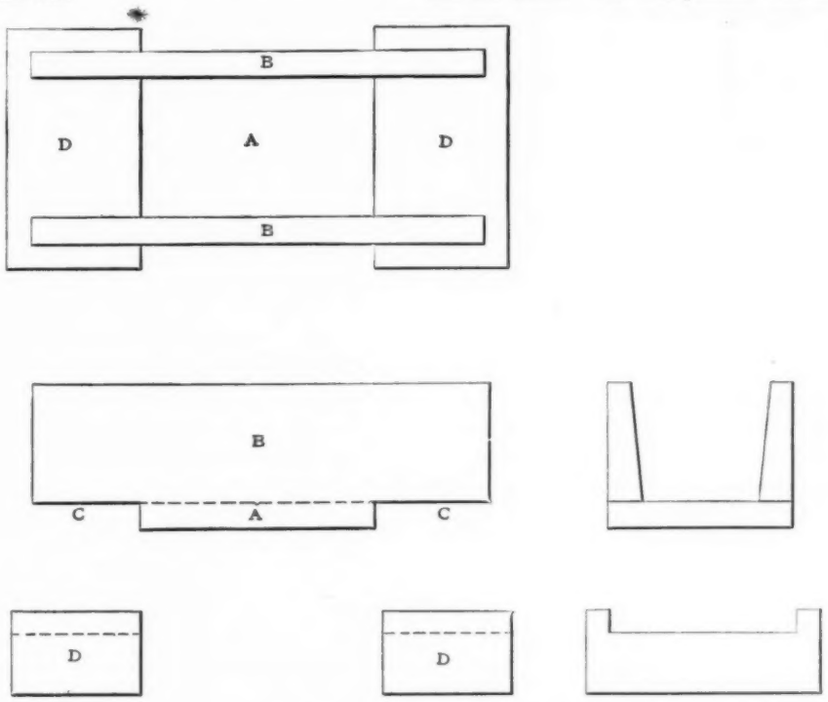
FIG. 5. SOLUTION TO PROBLEM VIII.

Towing the Floating Dry Dock "Dewey."

Probably the most remarkable and interesting undertaking of its kind is that of towing the mammoth steel floating dry dock "Dewey" from Solomons, Maryland, to Cavite, Philippine Islands. This dock was built by the Maryland Steel Company, at Sparrows Point, which is just below Baltimore.

It is 500 feet long, 134 feet wide and on a draft of 7 feet the side walls are 42 feet above the water.

It was completed in June, 1905, and was towed to the mouth of the Patuxent river where it was to be tested. On June 23 the U. S. S. "Colorado" was docked This is one of the latest and heaviest of the amored cruiser type and had a displacement of 13,300 tons at the time of the test.



THE FLOATING DRY DOCK "DEWEY."

The battleship "Iowa" was also docked on June 27 at which time the displacement was 11,600 tons. The specifications required that a 16,000-ton ship should be raised in four hours from the time she was placed on the blocks until the keel was out of water. From the time the "Iowa" was placed on blocks until the keel was out of water was one hour and thirty-seven minutes. The test, therefore demonstrated that this dock is capable of exceeding the requirements in time of operating, and capacity. It showed that a 20,000-ton ship could be docked so that all parts of the bottom would be accessible.

A novel feature of this dock is that it can not only lift a 20,000-ton ship out of the water but it can also lift itself out of the water so that its own bottom can be cleaned and repaired.

To describe how this can be done it will be necessary to refer to the sketches. The dock is made in three sections. The main section or pontoon is a rectangular box *A* with two side walls *B*. These side walls project over the main part of the pontoon on each end, forming recesses as it were, at *C*. In addition to the main pontoon there are two end pontoons *D* which fit into the recesses to make the affair complete for docking a vessel. Now when it is desired to get at the bottom of the main pontoon the end members *D* are sunk by opening valves and filling the compartments until they can be floated under the main pontoon, after which the water is pumped out until that pontoon is floated so that there is a clearance of five feet between the bottom and the water. The end pontoon can be cleaned by sinking the center one and floating the ends onto it the same as a ship would be docked.

The cost of this mammoth dock was about one and one-quarter million dollars. It contains 11,000 tons of steel plates and is held together by about 2,000,000 rivets; it required about 130 tons of red lead and oil to paint it.

Wonderful as is the dock itself, still more wonderful is the fact that the U. S. Government is to tow this unwieldy craft across the broad Atlantic and through the Suez Canal and Indian Ocean to its destination at Cavite, P. I., a distance of about 12,000 miles. It is expected to travel about 100 miles a day which will make the total time required for the trip about four months. To tow this dock the Government has detailed the supply ship "Glacier" and the colliers "Cæsar" and "Brutus." The "Brutus" will be next to the dock with "Caesar" next ahead and the "Glacier" in the lead. The tow will be a mile and a half long which is the longest in history. The Government has taken every precaution possible to insure the safe arrival of the dock at its destination. The most important part of the apparatus for towing is the Shaw & Spiegh automatic towing machines which are made by the American Ship Windlass Company, of Providence, R. I., and one of the largest sizes of which has been installed on each of the three steamers mentioned. These machines are installed on the stern of the steamers and each carries a 1200-foot steel wire hawser 2 inches in diameter. To the end of the hawser on the "Brutus" will be attached a manila hawser 5 inches in diameter doubled, which will be 600 feet long, and attached to this will be a bridle made of 2½-inch chain and 270 feet long, the ends of which are made fast to two sets of double bitts or towing posts which are on the dock. The peculiar feature of the towing machines before mentioned is that when a strain comes on the towing hawser which is greater than the machine is set to stand, the machine will run backward and pay out the hawser, and in doing so it opens a valve automatically which allows more steam to pass into the cylinders until the pressure in the cylinders equalizes the strain on the hawser. Then when the extra strain on the hawser has passed there is of course too much steam in the cylinders to balance the normal strain on the hawser and the latter is therefore wound in again to its normal position and the valve closed. This operation is repeated as often as a heavy sea strikes the dock and it will therefore be seen that this machine affords great elasticity in the tow line and prevents it from parting as would be the case under ordinary conditions. One of these machines was also used for towing the dock which is at Algiers, La.

In addition to the three steamers mentioned the U. S. tug "Potomac" is to accompany the dock as a despatch boat. This tug is also fitted with one of these towing machines.

Commander H. H. Hosley, who is the Supervisor of New York Harbor has been temporarily relieved so that he may take charge of this expedition. Capt. J. D. Wood, who has been master of tugs at Norfolk, is to have charge of the dock itself. There will be two crews on the dock during the trips, a deck crew of sailors and an engineer crew. They will live in the side walls of the dock which are provided with nine staterooms for the officers and ample accomodations for the crew. There will be a complete

distilling apparatus for making fresh water and the men will be abundantly fed as the usual rations have been doubled. It will cost $25,000 in dock fees alone for the dock to pass through the Suez canal, and in addition to this all of the buoys in the canal will have to be taken up and then reset again, as the dock is 134 feet wide and the canal only 150 feet in the narrowest place; this expense our Government will also have to pay. There has been about $75,000 expended for towing gear such as towing machines, steel and manila hawsers, chains, shackles etc., besides the expense necessary to fit up the steamers for this work and the expense of running the steamers and paying the crews of steamers and dock until it reaches its destination. It will therefore cost probably all told about $250,000 to deliver the dock, and for the steamers to return.

It is certainly a great undertaking and it will be watched with a great deal of interest until the arrival at Cavite, as all the steamers and the dock are supplied with wireless telegraph apparatus so that probably reports will be received very often. Each steamer is also fitted with a powerful searchlight which will be kept on the tow line astern of it, so as to prevent any vessel from running across it on a dark night and cutting it in two.

The dock has been fitted with the anchor windlass that was formerly on the U. S. S. "New York." This windlass was also built by the American Ship Windlass Company. It handles four 2½ chains two of which will be used at each end of the dock—with a heavy anchor on each chain.

Nearly all the nickel used in the United States is obtained from Canada, with a small quantity from New Caledonia. For this reason the production of nickel ore in Canada is of especial interest to the users of the metal in the United States. In 1903 the nickel output aggregated 12,505,510 lb. In 1904, however, there was a falling off of approximately 2,000,000 lb., as compared with the nickel content of the matte in 1903. A better quality of matte, containing a much larger percentage of nickel, has been obtained during the last few years.—*The Engineer.*

In wire-drawing, because the wear upon the hardest steel dies precludes the possibility of a uniform wire diameter from begining to end of the drawing, diamonds are now extensively used for dies, especially for small wire up to about 1/40-in. in diameter. The diamonds used for this work weigh from four to five carats each. With these dies it is said to be quite practicable to draw platinum wire to a diameter of 0.0005in.—*The Engineer.*

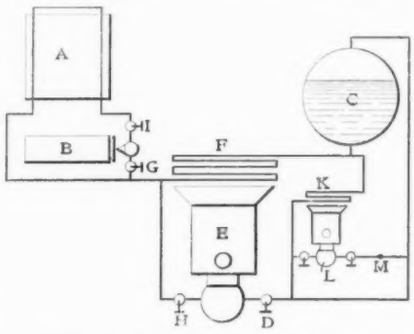
Riches have wings, but Poverty has spurs.—*Ideal Power.*

Letters to the Editor.

Starting a Gasolene-Fired Boiler.

It is known that to burn gasolene under a boiler for steam making it has first to be under pressure, and secondly, must be evaporated to gas. Owning a steam automobile and desiring to improve on the burner, I made several experiments with gasolene burners. Ordinarily the gasolene is evaporated by passing the feed pipes to the burner through the tubes or steam space of the boiler and it is also exposed to the fire. To start the fire when the boiler is cold, some part of the feed pipe or burner must be heated and several ways are used, mostly consisting of burning alcohol or gasolene.

I objected to these methods, as if alcohol was used, it was necessary to carry a quantity of it along, and gasolene makes a nasty smoky fire. Since the pressure in



STARTING A GASOLENE-FIRED BOILER.

the gasolene tank is obtained by compressed air and this air becomes charged with vapor, making it inflammable, I concluded to use it in a Bunsen burner for the preliminary heating. The scheme tried is shown in the accompanying sketch in which *A* is the boiler, *B* the burner and *C* the gasolene tank with oil level and pipe connections as indicated.

To start burner, valve *D* is opened, allowing air charged with gasolene vapor to burn in the burner *E*, heating coil *F*. When *F* is sufficiently hot so that the gas will burn properly at *B*, by opening valve *G*, *D* is shut off and gas for *E* taken from coil *F* through valve *H*. After 60 pounds of steam pressure is obtained in the boiler, valve *G* is shut off and *I* opened. This lets the boiler do the evaporating, and burner *E* is dispensed with.

It was found that burner *E* when starting took a lot of air, hand pumping being necessary all the time valve *D* was open, so a third smaller burner to be used as a preheater was introduced, arranged as shown in dotted lines which will be understood without description. The whole was contained in the large burner *B*; owing to this not so many valves were needed as shown in the sketch. After shutting off the air and vapor mixture from the top of the tank, much trouble was experienced in getting complete evaporation. About as regular as pulse beats, squirts of gasolene came through, making a smoky flame. The coil *K* was filled with grains of hard solder and heated to redness so it appeared impossible that unevaporated oil could go through, and the reason for the trouble became apparent. Although the coil *K* was red hot for about 6 inches and the distance from *K* to *L* was only about 4 inches, this last length was sufficient to condense the vapor back to gasolene.

Up to this time I thought that gasolene once evaporated into gas, would stay as such, but evidently this is not the case. I have since learned more about it from oil refiners, but, aside from these, out of one hundred ordinarily well informed men, nearly all will think as I did, and thinking is not necessarily knowing. From these trials I learned that where gasolene is to be burned as a vapor, it must be heated very close to the point of issue, so that the vapor will get no chance to condense. The common gasolene blow torch is an example of this.

It will be noticed that the burners are provided with air holes, as in a regular Bunsen burner. These are of no use, as the vapor given off from the gasolene contains sufficient air for combustion.

The air pumping not being to my liking, the happy idea of using acetylene generated under pressure struck me. Before trying this I made reasonably certain that a mixture of acetylene and oil vapor was a safe proposition, but took no account of heat. I determined fc the sake of safety to handle only small quantities in the experiments, and it was a precaution well taken. Accordingly a couple of capped nipples with a valve between them were put together, one of the nipples for carbide and the other for water. By opening the valve, water would come in contact with the carbide and acetylene gas be generated. There was now no trouble to get pressure and it only remained to make a satisfactory working outfit. So it seemed. For the different experiments, except where subject to heat, ⅛-inch pipe fittings and 5/16-inch brass tubing were used. Threaded plugs were bored plain 5/16 inch and the tubing soldered in the plugs. The acetylene gas connection was made at about point *M*.

The small burner was started and when the pressure commenced to get low I turned on the acetylene and had the satisfaction of seeing the pressure gradually rise. All of a sudden there was a rip and tear and several of my soldered joints flew apart. Although the total effect was small, I could plainly see that it was an explosion, and began to think that I was not yet through with hand pumping. I made a number of experiments and nearly always succeeded in getting an explosion.

I demonstrated to my entire satisfaction that acetylene is very treacherous and can explode if its container is heated, whether it be mixed with air or not, and with almost any mixture of gasolene vapor or common coal gas. One would hardly think

that it can explode alone without air or some other mixture, but it does. The violence of the explosion seems to be in proportion to the pressure, which might be expected since there is more of it at high pressure. It follows that I gave up the idea of obtaining pressure with acetylene, and it occurs to me to ask: If a village is supplied with a central gas plant with this gas, and if a house in which the pipes are laid catches fire, will the whole gas plant be blown up? PLATIUS.

Manufacturing Drop-Forging Dies.

It quite frequently becomes necessary to duplicate dies when a greater amount of forgings are required than can be made in one set of dies. For this purpose, if the face of the die is not too irregular in shape I consider the use of a former invaluable. It is quite common practice to use a former plate fastened to the die with either screws or dowel pins, but the greatest objection to these methods is the drilling of holes in the die, with the possibility of not getting the holes in the same place in the top and bottom dies, which would render the matching of the impression imperfect, and also the difficulty of replacing the former when it becomes necessary to remove it to measure the depth of the impresion.

The method which I describe entirely overcomes these objections. There is no expense attached to this method after the frame or band which encloses the die and holds the former plate in position is made.

Fig. 1 shows the former plate with attachments. The holes *a b c* are transferred from the frame and countersunk to receive the flathead screws which fasten it to the frame. The plate is made of cast steel ⅛ inch in thickness, planed on the edges to fit the frame, and is tempered in oil.

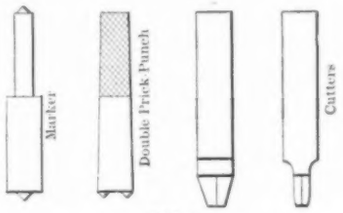


FIG. 4

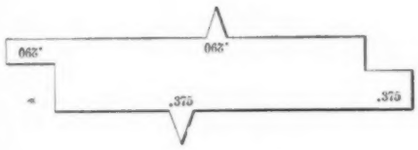


FIG. 5. DEPTH GAGE NOT TO SCALE.

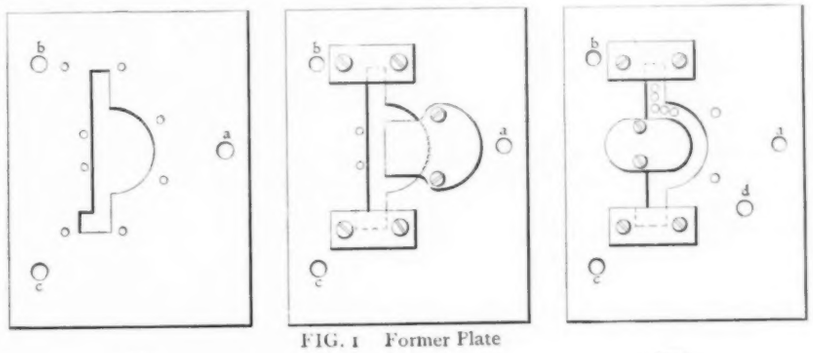
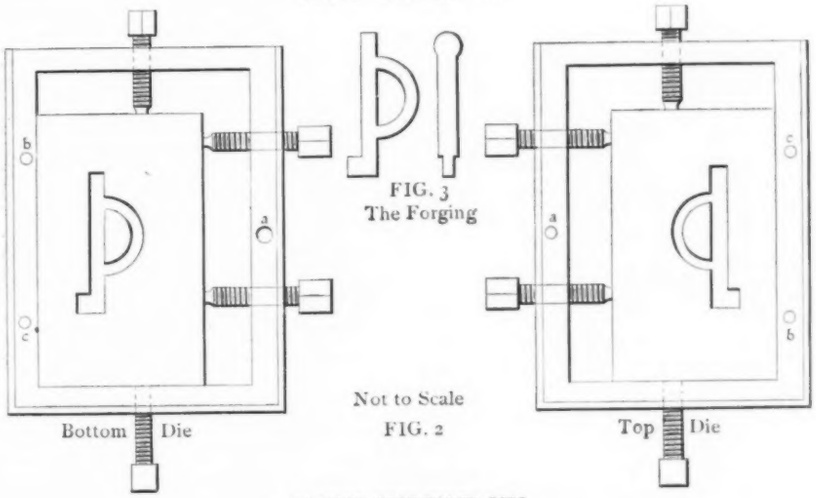


FIG. 1 Former Plate



MAKING DROP-FORGE DIES.

Fig. 2 shows the frame on both dies. The confusing part of this arrangement is in changing the frame from the bottom die to the top die. As it is customary to match the dies from the left-hand side and the front end, the frame is placed against these sides and the adjusting screws tightened to hold the die. There is but one of the end screws used, which should be the one on the back end; the other must be screwed back out of the way. The former plate is turned over and half way around when changing from top die to bottom die. In making the frame, screw-hole *a* must be in the center—that is, the same distance from each end—on account of working from one end of the frame on the bottom die and the other end on the top die. Hole *b* can be drilled any place after the screw is inserted in hole *a*; then turn the former plate over and transfer hole *c*. Fig. 3 shows the forging to be made. Fig. 4 shows the marker, double prick-punch and cutters used. When the former is on the die, by using the marker you can get the center line and with the double prick-punch lay out holes and drill out some of the stock as shown in the third sketch of Fig. 1. If the shape of the pieces will allow the use of the milling machine, the drilling can be avoided. It is best to place two strips of sheet steel about $^{1}/_{16}$ inch in thickness on the face of the die, when profiling; these will hold the former plate away from the die far enough to allow the chips to work out. Fig. 5 shows the style of depth gage used. By placing the drill or cutter on the face of the die and setting the stop on the drill press or die-sinking machine with the projecting end on the gage, the right depth is secured. There is a hole drilled in the former plate in any convenient place to allow the cutter to come in contact with the die without removing the plate. (See third sketch in Fig. 1, hole *d*.) It is not necessary to have a frame for every size die, as blocking can be inserted and the same result obtained.

This system is in use at the United States arsenals for manufacturing the magazine rifle at Springfield and Rock Island, and Smith & Wesson's pistol factory at Springfield, and it is claimed that the cost of dies is reduced fifty per cent.

JOHN H. SULLIVAN.

Chicopee Falls, Mass.

Brazing Gray Iron.

Noticing recently some mention of brazing with borax as a flux, I suggest boric or boracic acid as a substitute.

It is preferable to mix the acid, which is a powder, with water to a thick paste, painting it along the joint, covering it thoroughly so that when heated the melted flux will cover the surfaces to be joined. If the fracture should measure more than about five eighths of an inch across, it would be well to place a coating between the surfaces to be joined also, wiring or otherwise fastening the pieces together securely.

I have successfully joined steel to steel, steel to gray iron and gray iron to gray iron, the latter when surfaces were clean bright metal and a fairly close fit, using brass brazing wire and a soft coal fire.

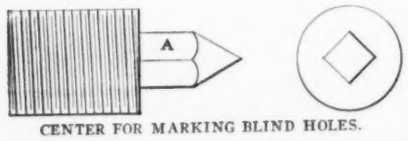
Upon trying the same means on a fractured piece of cast-iron, the brass could not be made to adhere to the rough surfaces, but after touching both surfaces on an emery wheel—so as to smooth and brighten them as much as possible without changing the general shape, and preserving the outer edge all around to keep the alinement for the mended piece—a union was obtained, but on account of the thick layer of brass, the joint was not quite as strong as one made between closely-fitting pieces. I send in separate package samples, the joined pieces are gray iron, the brazed surfaces of which were filed smooth, the small piece of gray iron is part of a fractured piece which was ground slightly on the broken surface and then brazed, afterward being twisted off. E. J. BOWERS.

[The samples sent appear to be just as strongly brazed as those where borax was used. One thing in favor of boric acid is that it is easier to remove after the job is done, boiling the article in strong soda or soap water being all that is necessary. Even without boiling, it is not nearly as hard as fused borax.—Ed.]

Marking Blind Holes—Triple Centers —End Mills.

The scheme by Mr. Fish at page 32 for marking blind holes reminds me of the method I have used for some time for doing similar jobs. It consists simply of a threaded center as shown. It is of tool steel, hardened. I screw it into the tapped hole, leaving the point slightly projecting. A tap with a mallet or hammer does the rest when the piece to be marked is in position. The squared portion *A* is to insert or remove the center, using a socket wrench. A set of these centers is a useful thing to have in one's tool chest.

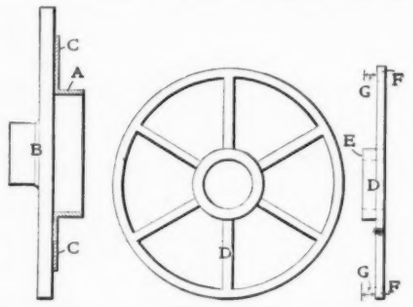
Referring to Mr. Salmon's triple centers at page 25, I would like to offer a suggestion. Why not make the two outer centers *dead*, allowing the gears, with dogs attached, to rotate on them. This would simplify the arrangement, as there would be no extra bearings to bother with, coupled with the certainty that all work done on them would be true with the centers. I would like to know through your columns why none of the large manufacturers of milling cutters list any other than straight and left hand spiral end mills. By left hand spiral, I mean so cut that there is *negative* rake—if I may use the term—on the end. I long ago tired of using this style for end cutting, and always make my own if I get half a chance; making the spiral right hand so as to give rake on the end teeth; also cutting them much coarser pitch. For instance, a 2-inch end mill for facing steel, I cut with 8 teeth, 20 degrees spiral, and only ¼-inch wide on the cutting face. I find a cutter so made will take a ¼-inch cut in steel with quite a coarse feed, and have never experienced any trouble from "hogging in" or digging, either on steel or gray iron. It will also take less power to drive. J. K. L.



CENTER FOR MARKING BLIND HOLES.

Securing Frail Work to the Face-Plate.

Frail work, that would be easily distorted in the ordinary chuck, may be securely held to the face-plate by means of plaster of paris. *A* shows a light brass casting. This was first gripped in a jaw chuck and rough-turned. It was then clamped to the face-plate *B* and centered. Plaster of paris was then poured around it at *C*. After the plaster set, the clamp was removed, and the job was turned and bored to size. When finished a sharp blow on the face-plate with a mallet jarred the plaster loose. The piece *B* was also of brass. In this piece the two faces *E* and *F* were required to be absolutely parallel. It was first caught in the jaw chuck, and finished all over, except the face *F*. A piece of brass was then clamped to the face plate and turned to fit the hole in the center. A shoulder was left for *E* to abut against. After placing it on the piece of brass the space *B* between the face-plate and the job, was filled with plaster of paris and allowed to set. This supported the thin brass and permitted it to be turned without chattering.



SECURING FRAIL WORK TO THE FACE-PLATE.

The following points are essential when using plaster of paris in this way: The lathe spindle must be a good fit in its bearings; there must be no grease or oil on the parts; the tools must be kept sharp.

If possible rough the casting out in a jaw chuck.

Of course such coarse feeds and high speeds as with a jaw chuck, cannot be used, but for holding odd-shaped pieces and accuracy it is excellent. Y. K.

York, England.

Cone Pulleys.

The arrangements of cone pulleys described below and shown by the accompanying sketches give such good results that they are in constant use and answer well the purpose for which they are intended.

The problem, the solution of which is shown in Figs. 1 and 2, was to drive two shafts from one pulley without the use of gearing or belts between the driven shafts and still preserve the change of speed of both so that one would not interfere with the other. Gearing was too expensive, and also made too much noise, as the speed was high. The driven pulleys were too close together to use a belt satisfactorily. We could not place two pulleys on the upper shaft, as the construction of the machine would not allow the driven pulleys to be that far out of line.

The arrangement shown in Figs. 1 and 2 was used. Fig. 1 is a top and Fig. 2 an end view of the pulleys. The pulley *A* had each step double crowned and was wide enough to take two widths of the belt to be used. The lower pulleys *B* and *C* were out of line with each other by the width of the belt, as shown in Fig. 1. The large steps of *B* and *C* were for one width of belt, and the other steps were the same width as those of pulley *A*, but crowned only on the outer half of the step, the inner half being relieved so that the belt could only run on the crown. They were belted as shown, the position of the belts being shown by the dotted lines. The pulleys *B* and *C* could be run at different speeds or like speeds, as desired, and the arrangement had all the advantages of two pairs of cone pulleys.

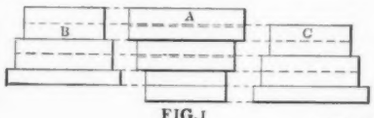


FIG. 1

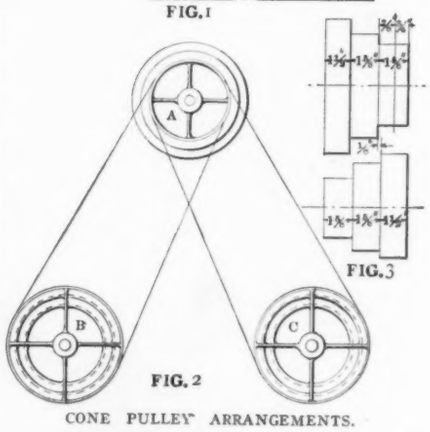


FIG. 2

CONE PULLEY ARRANGEMENTS.

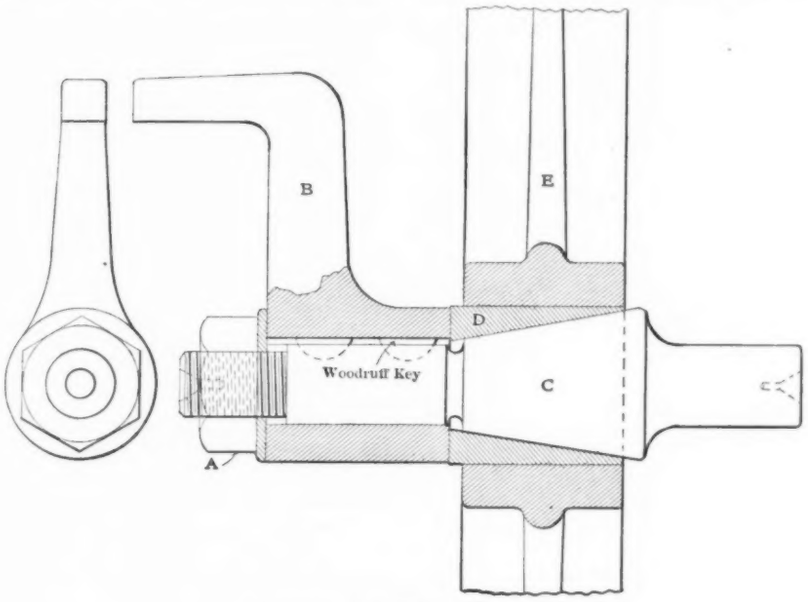
FIG. 3

Fig. 3 shows an arrangement of pulleys made to overcome the rubbing of the belt against the edge of the step where the room was so limited that the pulleys could not be made wider and for efficiency the belt could not be made more narrow, Two of the steps on each pulley were made 1⅝ inches wide, as before, for a 1½-inch belt; but instead of the center of the crown being exactly in the middle of the step, the distance was only ¼ inch from the outer edge of the step. This made the belt run flush with the outer

edge of the step and clear the adjoining step by ⅛ inch. The largest step was made 1½ inches, as here there was no step to clear. With the ends of the pulleys in line, the edges of the steps of the pulleys are ⅛ inch out of line, as shown. The pulleys we made before had all 1⅝-inch steps, with the crowns central, giving only 1/16-inch clearance for the belt. In the pulleys shown we have decreased the width of the pulleys ⅛ inch and yet have ⅛-inch belt clearance. L. B. F.

An Expanding Mandrel.

The illustration shows an expanding mandrel. The nut *A* draws the tapered



AN EXPANDING ARBOR AND ITS DOG.

mandrel *C* into the split bushing *D* and causes it to grip the casting *E*. The dog *B* is kept from turning by the keys.

I. N. QUIRE.

How Brown got the Pulley On.

"Say, Brown, I wish you would caliper that new beater shaft they are putting in out in the mill, and see if the pulley will fit all right. It is out in the yard and we'll have it rolled inside tonight, as they will be ready to put it on in the morning." Thus spake the master mechanic to the head machinist at the Tuffandstrong Paper Manufacturing Company about 4 o'clock one cold winter afternoon. The beater had been received from its builders a few days previously, while the pulley had done duty before. Brown got out his calipers and took the size of the shaft, 9 inches, setting his inside calipers before going out in the cold; he then stepped outside and tried the hole. "Whew! a drive fit!" He went back into the shop; and, as their facilities for driving or forcing a 1600-lb. pulley were rather inadequate, he began looking up a big new file. A 9-inch hole, 12 inches long, represented nearly 360 square inches, or, allowing for the keyseat, about 340 square inches. This caused Brown to do a little thinking. "That hole will certainly expand when they get it inside, where it is warm. But how much?" He went outside and looked at the thermometer on the corner of the engine room; 8 below zero. There was no thermometer in the beater room, but he estimated the temperature at 65. He then went to his desk and figured. The coefficient of expansion for cast iron .00000556×9 inches×73 degrees=.003, or just enough to let it slide on. Brown felt better, two minutes' figuring saved an hour's hard and useless work. He went out in the mill, noticing while on the way that the men were rolling the pulley inside, and reported to the master mechanic that the pulley would go on all right in the morning.

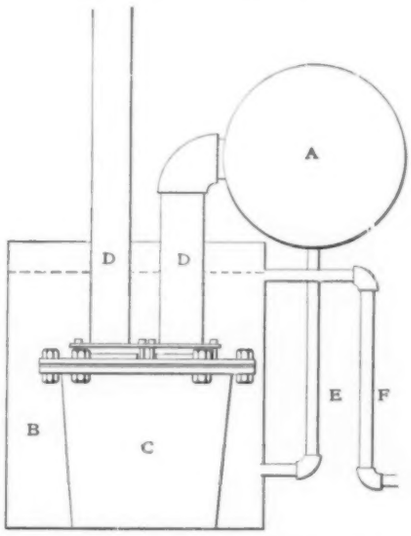
Just as the whistle blew at 5 o'clock Jones, the millwright—a man, by the way, who felt sure that there was only one class of men on earth who could measure to $^1/_{32}$ inch, and he belonged to that class—came into the machine shop. "Say, Brown, that beater pulley will have to be bored out; it's a sixteenth of an inch too small to go on the shaft." Jones was a hustler and his men had got the pulley into position quicker than Brown had anticipated. Brown hinted that the job would go together all right in the morning without boring the pulley, but Jones could not borrow money enough to bet that it wouldn't.

When the whistle blew in the morning Jones came to Brown. "How long will it take you to get that pulley bored out?" "Don't need boring," said Brown. "Let's go and see about it." Jones expostulated, saying it was no use, he guessed he knew, he'd tried it, etc. They went out in the mill, called the men and put the pulley on. It was a good fit, but it went on without driving. Brown felt triumphant, Jones puzzled and crestfallen; but he was so far from being a theorist that Brown thought it would be a waste of time to explain.

CHAS. A. TRASK.

The Utilization of the Waste Heat of Gas Engines.

Many people desiring small power, butchers and butter makers for instance, prefer steam to gasolene engines because of their need of hot water, which they think they can have more economically when they use the former power. That hot water may be had, however, hot as the hottest and plenty of it, is demonstrated by a device of Blaysdell whereby



UTILIZING THE WASTE HEAT OF GAS ENGINES.

he does much toward the heating of his shop by his gasolene engine without cost other than the usual running expense.

The device is shown in outline in the accompanying illustration, in which *A* represents the cylinder head, *D D* the exhaust pipe, *C* the muffler and *B* a galvanized iron tank of a capacity of about 80 gallons.

The usual cooling water is carried from the cylinder through the pipe *E*, into the bottom of the tank *B*, where it is heated by contact with the exhaust pipe and muffler before it overflows through the pipe *F*, thence passing through a coil of radiating pipes near the floor and back into the underground reservoir from which it was originally pumped.

Even in this case, where the source of supply is an underground tank of forty barrels capacity, and a constant flow is maintained through a long radiating coil, the water in the tank *B* is kept constantly close to the boiling point; and, if no circulation were used and the cooling water were not run into the heating tank at all, a large body of water might be kept boiling there, not only without any expense, but with some gain in the power of the

engine; for the cooling of the exhaust gases cannot help but relieve the back pressure to some extent.

It was of course necessary to make the joints about the muffler water tight, but this was easily accomplished by the use of asbestos packing.

This device might be somewhat improved by using, instead of the usual muffler, a small steam boiler fitted up in such a way that the hot gases would pass through the flues, having water from an elevated tank circulate through the boiler proper.

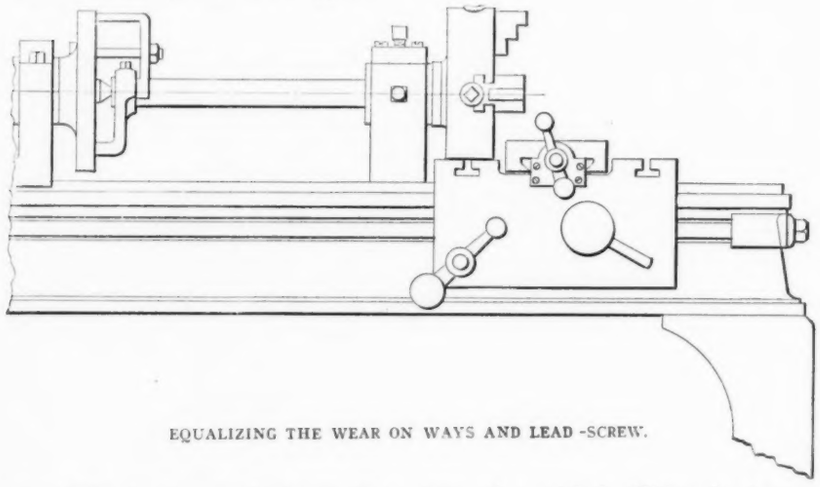
Two of the largest items wherein a gas engine falls short of perfect efficiency are in the loss of heat through the cooling water and that carried away by the gases of combustion, the utilization of any part of which is so much clear gain, while there seems to be plausible basis for the belief that the immediate cooling of the exhaust, relieving a portion of the back pressure, would enhance the power enough to pay for the installation.

W. D. GRAVES.

Equalizing the Wear on Lathe Ways and Lead-Screws.

The accompanying drawing illustrates a plan for equalizing the wear on lathe ways, and also a tapering method.

As will be seen, there is a supplementary spindle, bearing a chuck, or face-plate. One end is caught flexibly on the head-center and the other held in an adjusting box housed on the headstock ways.



EQUALIZING THE WEAR ON WAYS AND LEAD-SCREW.

This spindle may be of any convenient length, the object being to distribute the wear incident to short chucking work more evenly over the lathe-bed.

By adjusting the block-bearing, tapered work may be done.

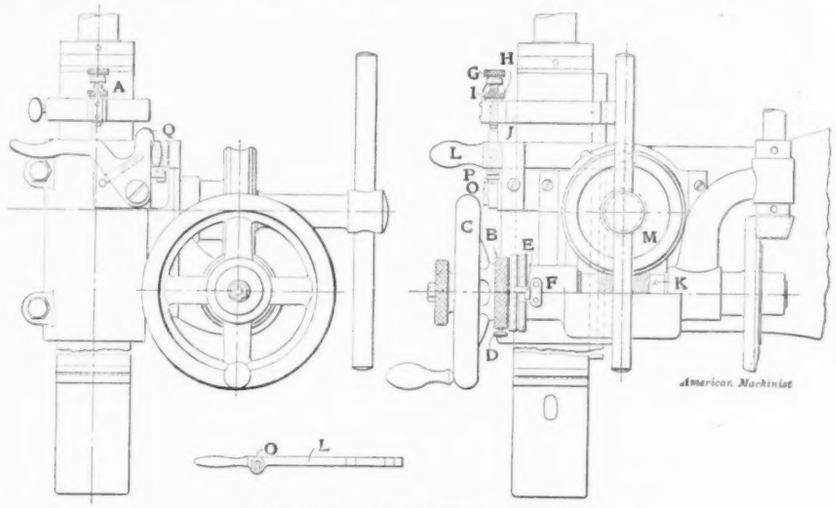
MAURICE R. WILLIAMS.

[Of course it would not pay to put this rig on the lathe for every chucking job, but when a lot of pieces were to be chucked, and especially if threaded, it might pay to distribute the wear in ways and lead-screw in that way. Ed.]

Improvements on Drill Presses.

The accompanying drawing shows some improvements we made on our drill presses. The spindle quill *A* is graduated into eighths of an inch by most builders, but in an up-to-date shop an eighth of an inch is not close enough even for a drill press hand.

In our shop it is the practice to figure the depth of counterbore in thousands of an inch, for instance the depth of counterbore of a ½-inch fillister head screw is marked .323 .327. To enable the drill press hand to work within these limits, we put on a dial B graduated to indicate thousands of an inch. On one machine we found that the rack pinion had 14T. 8P. 1¾ inch pitch diam. and 5.4978 inches circum. The ratio between worm and wormwheel was 55 to 1. Under these conditions it was not necessary to make any alterations in the gearing, as one turn of the worm shaft equals almost exactly one-tenth of an inch feed, the error being only .001 inch in 2¾ inches, so all we had to make was a dial with 100 divisions. In another drill press the conditions were not so favorable. The ratio between worm and worm wheel was 48 to 1; the rack pinion had 15 T. 8 P. 1⅞ inch pitch diam. and 5.8905 inches circum. In this case one turn of the worm shaft is nearly equal to one-eighth of an inch feed. To make it exactly one-eighth feed, we made a new rack and rack pinion and changed the pitch to .4 inch circular pitch. We used an 8 pitch cutter for cutting the teeth, but made the depth of tooth .275 inch. With 15 T and .4 inch cir. pitch the circumference at the pitch line is 6 inches. This divided by 48 equals .125 inch or ⅛ inch feed to one turn of the worm shaft. For this machine we made a dial *B* with double graduations as shown in the drawing. One part was graduated into 125 divisions, giving a reading of thousandths of an inch. The other part was divided into 8 equal spaces giving a reading of sixty-fourths of an inch. This dial was loosely mounted over the hub of the hand wheel C, and fastened thereto, after being set, by the screw D. The double pointer E is fastened to worm box F.



IMPROVEMENTS ON DRILL PRESSES.

The second improvement is the graduated screw G with the lock nut H and pointer I on the stop collar J. The old stop collar had only a projecting lug cast on, and it was no easy matter to set the stop just where you wanted it. The screw G has 25 threads to the inch and the head is graduated into 40 divisions. With this micrometer arrangement the stop collar is set approximately; the final adjustment is made with the screw G.

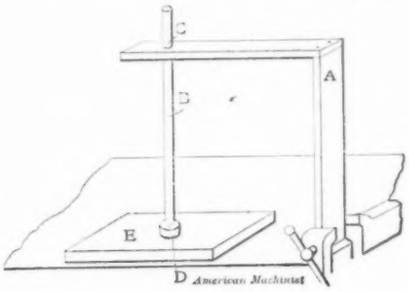
A further improvement consists in providing an adjustment on lever 4, in order to be able to keep the worm K in proper engagement with worm wheel M. We made a new level provided with a dovetail slot, into which we fitted a slide O, and a screw P to adjust it. The trigger O hooks over this slide and holds the worm in engagement with the worm wheel. If, on account of wear at the different places, the worm and worm wheel get out of proper mesh, it is only necessary to screw up the slide O a little and by doing

so, the worm box is raised and this brings the worm into deeper mesh with the worm wheel. H. I. C.

Lapping Rig for Steel Disks.

The sketch shows a simple arrangement for lapping (in this case) tool steel disks for bearings.

A is a wood frame of 2x4 stuff through

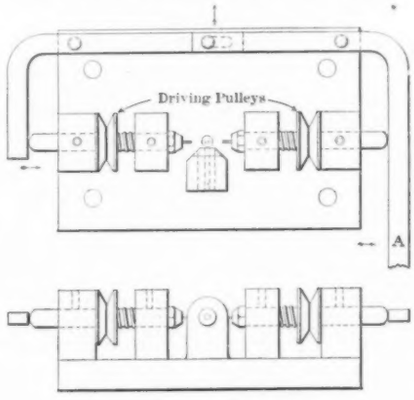


LAPPING RIG.

the upper part of which extends an iron rod *B*. The hole at *C* has to be sufficiently large to allow a free movement of the rod. The lower end of the rod is pointed and fits in the center hole of the disk *D* pressing it down on the lapping-block *E*. All one has to do now, is to move the disk to and fro on the lap the work thus being made considerably easier, for the pressing down is done by the rod *B*, which of course, has to be of sufficient weight to give the necessary pressure. By modifying the arrangement somewhat it might perhaps be used for other kinds of lapping.

A Special Drilling Machine.

The accompanying illustration shows a machine for drilling two holes simultaneously in the heads of screws. The base of the machine is gray iron in one piece. The pulleys, spindles and binding collars



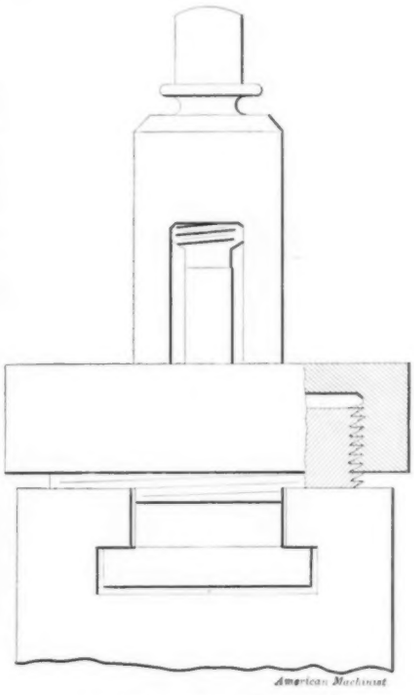
A SPECIAL DRILLING MACHINE.

are of soft steel. The spindles are case-hardened and split to hold the drills. They are driven separately by round leather belts, the same as those used on sewing machines. There is a clamp for holding the screws against the bushing and a device operated by the foot to knock out the finished screw. These are not shown in the illustration. Their object to leave both hands free to insert blanks and operate the feed lever *A*.

H. G.

An Adjustable Tool Post.

Touching the tool post subject, I have found considerable satisfaction in using a post having a large threaded collar for hight adjustment, as shown in sketch. I usually make tools for cutting on or slightly above the center, forging them as high as the lowest adjustment of the threaded collar will allow, of course at the same time considering the size of the tool steel and stability. After working with a post of this kind for several years and then changing to one of the hollow-washer tilting-piece variety, the latter



AN ADJUSTABLE TOOL POST.

proved a great aggravation, the least effort to shift tool for reach also changing the hight.

In using a post of the former description on work that required much changing of tools, the same tools being used again on duplicate pieces, it was found best to provide an assortment of steel pieces to use under the tools, several each of different thicknesses, so that a tool and its packing piece or pieces can be removed, kept together and quickly returned, bringing each tool to its proper hight without much changing of the threaded collar.

My idea of tool grinding is that the clearance should always be given by a certain angle with the base, the clamping plate having no angular adjustment in a vertical plane, then provide ample hight adjustment for grinding and make all changes of the clearance angle by regrinding the end.

In this connection a handy contrivance is a center hight gage for use on any available part of the tool block not covered by the tool post. This should have a true base and jointed arm so as to reach out for long tools or close in for shorter ones, the gage to be used only when hight of tool is important.

E. J. Bowers.

Catch Questions in Examinations—Dixie's Yarn.

Some examiners—both here and in Europe—are very fond of introducing catch questions into examinations. If these questions are merely to puzzle without having any practical value, the practice is bad. A carefully worded catch question may, however, sometimes detect weaknesses in a man's practical knowledge which a straightforward direct question would not.

For instance, if in examination a candidate were asked "Does the safety valve cap bear on the valve?" it is safe to say that the percentage of incorrect answers would be very low. For even those who do not know that the cap has no bearing on either the valve or its spindle would take care either by "cribbing" or otherwise to give a correct answer. If, however, the question is put in different form, it will not mislead those whose knowledge of the subject is sound, but will single out the ignorant, who should be disqualified.

This question, in the British Board of Trade examinations for marine engineers is put thus:

"A safety-valve 4½ inches diameter is loaded with dead weights, 6 of 70 lbs., and 9 of 60 lbs. each, the valve itself weighs 9 lbs, the spindle 16 lbs. and the cap 14 lbs.; what is the pressure of steam per square inch at which it will blow off?"

Should the would-be engineer forget himself so far as to add the weight of the cap to the sum of the other weights, he is failed and is generally sent back to sea for three months to learn the construction of the safety valve.

Another catch question is given at page 95, Vol. 24: "Q. Supposing you had gotten your boiler ready for sea, all the manhole doors on, and had tightened up the nuts on the dogs yourself—the gaskets all new and liable to be compressed somewhat. The ship leaves port; three or four days elapse and on going into the stokehold you notice that the dogs are all more or less loose. Suppose by some chance one of the dogs gets moved around on the stud in the door, so that the door can fall in. The steam pressure is 80 lbs. Suppose this door falls in, what would you do?"

The answer supposed to have been given shows that the candidate was not misled by the roundabout way the question was asked.

"A. I would immediately take off my clothes and dive into that boiler after the door; for a door that could fall in with 80 lbs. pressure in the boiler would be well worth investigating."

Diameters of taps, reamers, etc., having odd numbers of flutes cannot be measured with an ordinary micrometer. If a machinist were asked to measure a three-fluted tap with a micrometer, he would at once say it is impossible. The little yarn about the three-fluted taps needs some explanation. It was founded on two facts, an actual experience of my own while making a set of *four*-fluted taps, and a conversation I had with a mechanical friend on the subject of catch questions. He asserted that no practical man could be imposed upon by a catch question. The yarn about the taps is true up to where the three flutes are introduced. In order to make the three flutes plausible, Mr. Hale had to be either Scotch or English; as a matter of fact he was neither, but American. He did measure the taps with a micrometer, but as they had four flutes, that was easy. The yarn in its garbled form I sprung on my mechanical friend one night when he and I were going over old times, and to my delight the three flutes passed without challenge. Since then I have told the story many times and it has never been questioned. In cold type any yarn is different; a man has time to analyze and pick out the errors, there is not the magnetism of the story teller to lull suspicion and so the fallacies are more easily detected. I salute Messrs. Collins and Kohr who tripped me up at page 24, Vol. 29.

DIXIE.

Notes on Machine-Tool Design.

Change in design often reveals defects concerning a machine which passed unnoticed in its previous state. There is a deal of education in watching the effect of some alteration which often shows itself in a feature quite distinct from the one altered. A case in question was the alteration of a planer table from the "V" to the flat way with gib design. Figs. 1 and 2 show the original state and the alteration. One thing we have learned since the alteration is, that the table is weak in cross-section, and always has been, apparently. With the new table, anything bolted down tight by means of the two center stops springs the table so much as to lock it against the gibs at *A A*. The springing of the table had never been noticed before the change was made, though doubtless it was there. The wear on the ways seemed to be even, though, in face of present knowledge, it should not have been so.

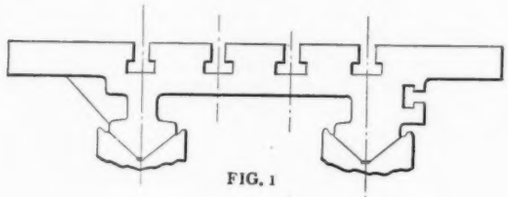


FIG. 1

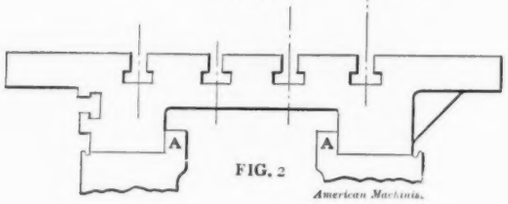


FIG. 2

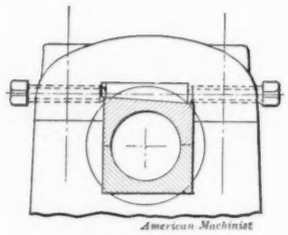


FIG. 3

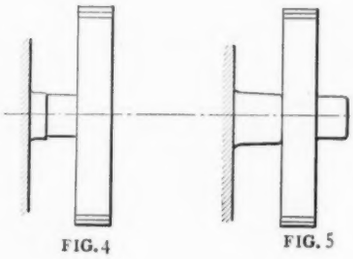


FIG. 4

FIG. 5

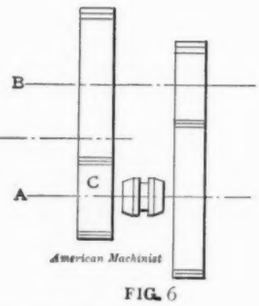


FIG. 6

POINTS IN MACHINE TOOL DESIGN.

I am not quite sure of the benefit of the lathe bearing proposed by Mr. Fish at page 493, but admitting the advantage of the wedge, why not put it in the cap? The cap shown in Fig. 3 is certainly more costly than the one Mr. Fish proposes, but when the top brass is rebedded—the only one which usually needs it—an advantage of the wedge might be felt.

Two thoughtless mistakes came to notice lately, one of which is fairly common. A wheel, large in diameter, was bossed up as in Fig. 4, when there was every opportunity of arranging it as in Fig. 5, which reduces the tendency to bell-mouth the bearing. The other was in regard to the position of the clutch shown in Fig. 6. It was put on the driving shaft *A*, and consequently when shaft *B* was revolved at its higher speed, pinion *C* rotated at very high velocity. It is only fair to add that *A* was the more convenient shaft.

A revolving shaft, even if without projections, is more deadly than it seems, as a recent accident shows. Some threads of a piece of waste hanging from a man's pocket wrapped themselves around a rapidly revolving shaft. Pulling his coat after them, the shaft whirled him to his death. There are too many shafts about machine tools left uncovered, some of them just where the operator has to stand. True, there are not many serious accidents, but the number of cases of torn clothes is considerable, and timidity of certain parts of his machine is not conducive to quick work on the part of the operator. Too often, though, the fault is partly the man's, through neglect to keep his overalls buttoned up tight, as a recent case tends to show: A man man bending over a boring bar had his coat caught, and had a mate of his not quickly stopped the machine, he would, in all probability, have been seriously hurt.

The question is raised by the reading of a recent advertisement in the AMERICAN MACHINIST as to whether the power absorbed in the operation of machine tools is of much moment. Looking at it from the standpoint of a man buying a tool—surely the correct thing to do—he has two machines in view, for one of which it is claimed that it uses only a half to three-fourths the power that the other does. He has line shafts, countershafts and other machine tools, all using up power. An additional horse-power is not of much importance. The cost of the power is only a fraction of some of his other operating expenses—labor, for instance—and hence the saving would be a fraction of a fraction, and would be almost negligible compared with such features as the handiness and rigidity of the tool. A machine tool may be inefficient mechanically, yet be a great success commercially. Of course, everything else being equal—a thing highly improbable, by the way—the saving in power is a direct saving, and if electrically driven, a saving would be made in the cost of part of the equipment—the motor.

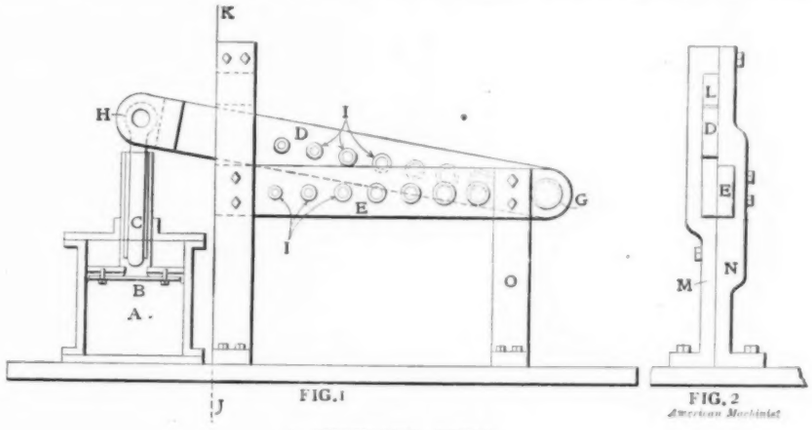
The recent tendency to cast speed charts and attach them to machine bodies is, it almost goes without saying, a good one. It keeps it where it is wanted, and it cannot be lost. Just now, in the effort to make them more compact, in several cases the spindle speed resultant of any combinations of gears, etc., has been left out, and the diameter of work for which such

combination is suited substituted, indicating, for example, that to drill an inch hole, say, in steel, handles *A* and *B* must be in position shown. This has a fault. It is based on the supposition of uniform hardness of material to be machined, which is practically impossible. Of course, in practice, the operator will get, in time, to know how to vary the speed to suit the material, notwithstanding the chart; but that is not the point. It is the supplying of information, presumably to help the operator, which is wrong, and which could be easily made right. H. T. M.

Manchester, England.

A Pneumatic Scrap Shear.

The sketch shows an air power shear that has been used for a number of years for cutting up round scrap iron. Quite a lot of bolts, etc., with threads stripped find their way to the scrap pile. These are cut off and sent to the bolt cutters to be re-threaded and can then be used again. It saves handling the scrap, as the scrap is culled at the scrap pile and was evidently devised to avoid carrying the scrap into the shop. It is located under a shed and is used to all kinds of weather, but is always ready for service. It was very easily made, no castings and very few forgings being required. This one was evidently constructed out of whatever was available and while it is no beauty it does the work. The cylinder is



A PNEUMATIC SHEAR.

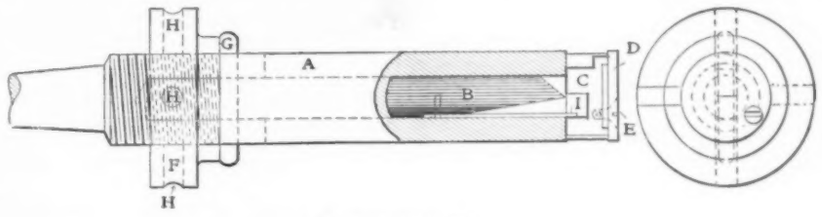
an old air brake cylinder. The piston B is of the trunk variety. The rod C is of course smaller in diameter than the hole in B in order to allow it to swing without throwing the piston out of line. The bar E is stationary, the bar D being movable and fulcrumed at G. The bar D has jaws at H to straddle the rod C. The bushings I are tool steel tempered and pressed in. They seem to have no tendency to back out and have remarkably long life. The support M holds the movable bar D close to E. Fig. 2 shows the end view at line J-K. L is a piece of rubber for a buffer to absorb the shock when a rod is sheared off. The air is controlled by an ordinary three-way cock which is so mounted that it may be operated by the foot, thus leaving both hands free.

The sketches are not to scale, nor are they exact in detail, but give a general idea of the construction of a very cheap, serviceable and easily constructed shear to be used in an isolated place where other power is not convenient and where compressed air is available.

W. T. H.

A Recessing Tool.

At Page 789, Vol. 28, Part 2, there is shown a sketch of an internal recessing tool which put me in mind of one I had made for a similar purpose a few years ago. This may be of interest in showing another way of doing the same job. One advantage I found in this style of tool was that it left the tool holder free to bore out the hole in the job the required size without putting any other work on the tool except what it was designed to do *i. e.*, the recessing only. The sketch



A RECESSING TOOL.

shows the general design of the tool, but a little explanation of its construction will make it easier to understand. The bar *A* is turned an easy fit in the hole to be recessed and is drilled for the plunger *B* which forces out the cutter *C* fitted in the slot at the end of the bar and held in position by a cap *D* fastened by four flat head screws *E*.

The cutter is slotted so as to allow the coned or beveled end of the plunger *B* to work into it, thus forcing the cutter out. The end of the plunger is forced into it by turning the nut *F* on the end of the bar. The bar is slotted for the pin *G* which is fitted in the plunger *A*. The nut is provided with four tommy holes *H* for turning it. The end of the plunger is cut away for the flat spring *I* which forces the cutter *C* back when the nut *F* is screwed back. The end of the bar is tapered to fit the spindle of the tail stock. The cutter is relieved in the ordinary way and is ground on the top so as to keep its shape until nearly worn out.

C. PETITJEAN.

London, England.

Making Wooden Rolls.

At page 18, Vol. 28, Part 2, I wrote a description of how wood rolls were made for textile purposes, but since that time I have seen what was to me a new idea in that line and as it works better and costs less, it is worthy of attention by all in that line of business.

The bottom roll in washing machines is generally 12 to 14 inches in diameter and 10 to 12 feet long and runs at all times under from 2 to 4 feet of water. The less the iron work in this roll weighs the longer the boxes will last and it is partly because of this, that the size of the shaft through the center was always made about half the size of the shafts in the other rolls.

This new method eliminates the shaft entirely. The log is cut off as much longer than the finished face of the roll as the length of the journal boxes will allow, less two inches, and after finding the center, a lag screw approximately ⅞ by 10 inches, with a center hole drilled and countersunk in the head, is screwed in each end. Upon these centers the roll may be turned. Putting the log in the lathe the journals may now be turned down to 4½ inches in diameter, one inch shorter than the journal boxes, the extra inch being for clearance for the lag screw head. Cast-brass sleeves, previously bored 4½ inches, made as long as the turned journal and approximately one inch thick, are now forced on the journals and the wood wedged up solid with iron wedges in the usual manner. These brass journal sleeves are then turned to a diameter of 6 inches and the face of the roll finished in the regular way.

Rolls made in this way will give excellent satisfaction when run in wooden journal boxes, care being taken not to fit the boxes too tight.

This roll merely acts as a carrier roll for the strands of cloth to immerse them in the water. L. L. ARNOLD.

East Greenwich, R. I.

Micrometer Stops.

As I read the various letters in the AMERICAN MACHINIST I often think, "if I had only seen that letter before I did such and such a job, how differently I would have gone about it." As micrometer stops of various forms seem to be in order at present, here is another one that I designed. Almost all modern drill presses have a stop, but it is a common screw without means for reading to any definite part of an inch. The clamp body *A*, Fig. 1, is made of tool steel and spring tempered. On the side a thin slot is milled through to the center hole. *B* is a clamping screw, with a pin in the center for a handle, the head of which is turned off until the pin-handle stands vertically in the drill press when *A* is clamped to the spindle, so as to clear the drill-press handle *C*. On the front end a ¼-inch hole is drilled, tapped 40 threads and a fine slot milled through into it. A ⅛-inch machine screw on the side takes up the

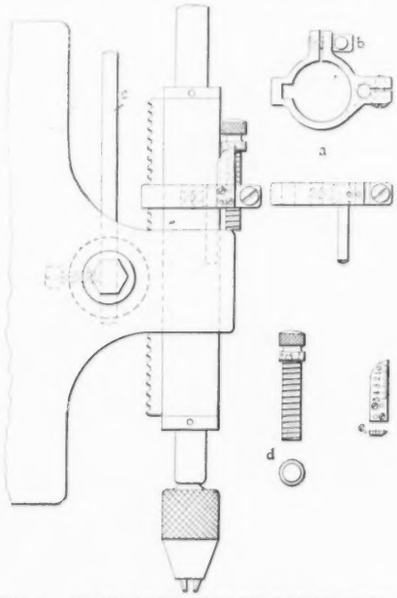


FIG. 1. MICROMETER GAGE ON A DRILL PRESS.

wear, or clamps the micrometer screw in position when drilling a number of holes the same size. The screw *D* is made of tool steel ¼ inch diameter, 40 threads, with the bottom end hardened. The head is nurled and its diameter is 1/64 inch under the diameter of the register head which is graduated with 25 divisions, each equaling an end movement of the screw of 0.001 inch. A thin, sheet-steel plate is fastened to the body *A* with two screws and two dowel pins. This forms the main body of the stop. It is graduated every 0.025 inch for a distance of ½ inch.

I don't think I have ever seen a micrometer stop for a drill press published, still we have used this for a number of years and it has proved very satisfactory. In the drill press, as well as in a lathe, we sometimes have work which requires to be machined to a depth within a limit of a thousandth of an inch. This gage is very cheap and simple to make.

Fig. 2 is one of the cheapest and simplest micrometer lathe and shaper stops I have ever seen. I prefer it to the high priced and complicated ones. Without doubt this is one of the most accurate and universal tools in use. It is, however, often necessary to use the stop at different lengths, to accommodate different lathes and shapers. Then again we may wish to use it on the right as well as the left side. The form of holder shown in Fig.

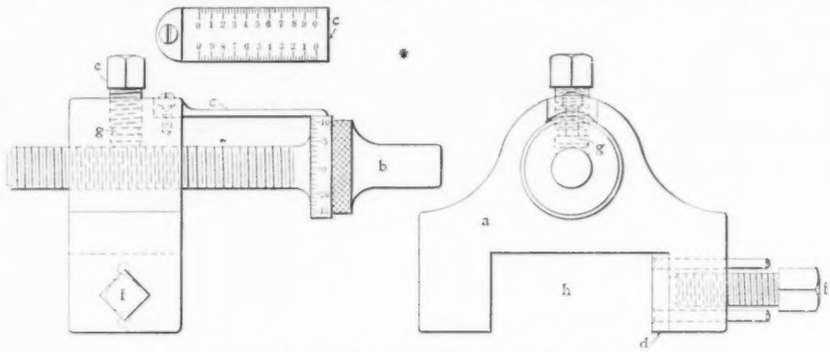


FIG. 2. MICROMETER GAGE FOR LATHE OR SHAPER.

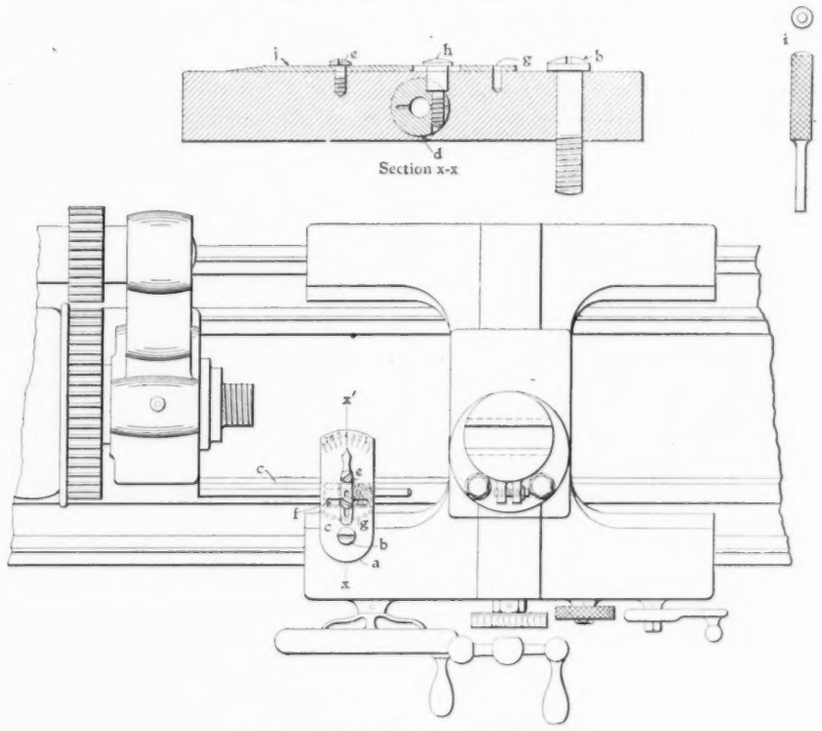


FIG. 3. INDICATOR FOR THE LATHE.

2 can be used either right or left, and for various heights and depths. The body *A* is made of machinery steel case-hardened. Through the top is a ¼-inch set-screw *E*. In the bottom is fitted free a ⅛-inch thick copper piece *D*. With the aid of the set-screw the micrometer screw can be locked at any position, with no fear that it will slip. The micrometer screw *B* is of tool steel, and cut 20 threads to the inch. The end is turned and nurled. A plain space for dividing is left a little above the nurling to clear the register head. Both ends are hardened so that the micrometer screw can be used on either side. The register hand *C* is made of tool steel 1⅝ inches long, ½ inch wide and fastened on top with a machine screw. On each side one inch of space is graduated, the lines being 0.025 inch apart. This is done so that the graduation can be easily read in any position, or to read on the right of the machine as well as on the left. On the bottom a space *H* is milled out large enough to fit the different machines. The width of the slide of the shaper is generally one inch, while the bed of a lathe is about ½ inch. On the side a 5/16-inch screw *F* is fitted. To keep the surface of the slide and bed from being marked by the end of the set screw, a shoe *D* is made with two pins, a sliding fit in holes in *A*. With it the set-screw will clamp the holder securely. Fig. 3 was designed for internal work in the lathe, but it has been found to be very useful on external work as well. It has also been used in a milling machine on inside work which it is impossible to see or measure easily. This is not a micrometer but an indicator, but

if properly made will register as close as a micrometer. The body *A* is made of machinery steel 4¼ inches long, 1½ inches wide and ⅝ inch thick, held on the machine by a screw *B*. In the center is drilled and reamed a 3/16-inch hole to fit the rod *C*. A ½-inch counterbore with a 3/16-inch tit is countersunk down about ⅛ inch from the bottom. On the end the ½-inch hole is tapped out and a screw fitted ⅜ inch thick, with a screwdriver slot and a 3/16-inch hole to fit the rod *C*. In the center of the hole is a bushing *D* which is a free fit in the ½-inch hole and the rod. *A* slot is milled in the center, tapped and counterbored on the side to fit the screw *H*. This acts as a clamping screw, as well as a guide for the register hand *J*. It moves freely in the elongated slot *F* and in the elongated slot in *J*. Between the bushing and the end screw is a light spiral spring that keeps the bushing *D* against the other side, so when registering the rod will always be against the side of the machine when the slide comes up and pushes it back until it registers the required number. The register hand *J* is made of 1/16-inch sheet steel and swings on the screw *E*. On one end is a 1/16-inch hole *G* which corresponds with a number of holes drilled in a circle from the center of the screw *E* in the body *A*. The reason for having these holes is that when a certain number is wanted on the register, say 4, we unloosen the clamping screw *H* and place the hardened, ground and lapped plug *I* in the indicator hand and move it along until it registers 4, then drop the plug down into the holes in the body *A*, now move the slide up to the position wanted, when the rod *C* is against the wall tighten the clamping screw *H*, withdraw the plug *I* and the registering is 4. The graduations on the indicator register .010, but the lines are nearly ⅛ inch apart, so that finer graduations can be made if wanted. The graduations must be made by hand. Clamp a depth gage and the indicator stop parallel to the rods on the surface plate, move the depth gage .01 or .001 inch as wanted and draw a fine line, and so on; when finished, take a small fine chisel and sink the lines deeper. The reason it cannot be graduated in the milling machine is because the graduations vary as the indicator hand moves in a circle.

RADIUM.

Table of Proportions of Differential Back-Gears.

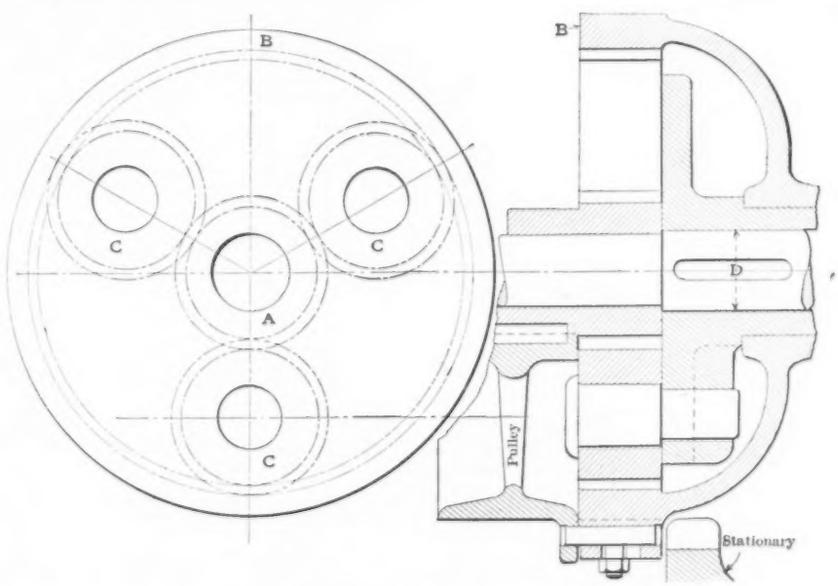
For a back-gear on a machine with a light drive the differential back-gear as originally designed is still used on drill presses and other light machinery. For a heavy drive and continuous service there is a better method of arrangement. This consists of using three idlers in place of one, these being equally spaced in order to retain the balance of the whole when locked up and driving direct. It will be readily seen that this arrangement calls for the following conditions in the gearing: That the number of teeth in pinion, idler and internal gear must each be divisible by three, at the same time having correct diameters and pitch.

A table is given herewith showing drives from 2½ to 18 horse-power in 12 sizes. This is arranged so that there are only 6 different diameters of internal gears, and by using different pinion and idlers one size can be used for two different ratios.

Fig. 1 shows the principle on which these back-gears are operated. The locking device should not be copied, however, as it would be rather inconvenient to use, and as there are various methods of operating clutches the writer has not gone into detail on this point, but gives the general dimensions, leaving the rest to be worked out by the designer to suit the re-

Size No.	1	2	3	4	5	6	7	8	9	10	11	12
Dia. of Pulley	8	8	10	10	12	12	15	15	15	15	18	18
Face of Pulley	3	3	3½	3½	4½	4½	5½	5½	6½	6½	7½	7½
Width of Belt	2½	2½	3	3	4	4	5	5	6	6	7	7
Approx. H.P. at 300 r.p.m.	2½	2½	4¼	4¼	7¼	7¼	11	11	13	13	18	18
Shaft Diam. D	1½	1½	1½	1½	1⅝	1⅝	1¾	1¾	2	2	3	3
Pitch Diam. Pinion A	2¼	4½	2⅓	5⅓	2⅓	5⅓	2⅓	6	3	9	5	13
No. Teeth in A	18	36	18	36	18	36	18	42	18	54	15	39
Pitch Diam. Internal Gear B	9	9	10⅔	10⅔	10⅔	10⅔	12⅔	12⅔	18	18	25	25
No. Teeth in B	72	72	72	72	72	72	90	90	108	108	75	75
Pitch Diam. Idler C	3⅜	2¼	3⅔	2⅓	3⅔	2⅓	5⅓	3⅓	7⅛	4½	10	6
No. Teeth in C	27	18	27	18	27	18	36	24	45	27	30	18
No. of Idlers	3	3	3	3	3	3	3	3	3	3	3	3
Diam. Pitch of Gears	8	8	7	7	7	7	7	7	6	6	3	3
Face of Gears	1¼	1¼	1⅛	1⅛	1⅝	1⅝	1¾	1¾	2	2	3	3
Ratio	5 to 1	3 to 1	5 to 1	3 to 1	5 to 1	3 to 1	6 to 1	3.142 to 1	7 to 1	3 to 1	6 to 1	2.923 to 1

TABLE OF PROPORTIONS OF DIFFERENTIAL BACK-GEARS.



DIFFERENTIAL BACK-GEARING.

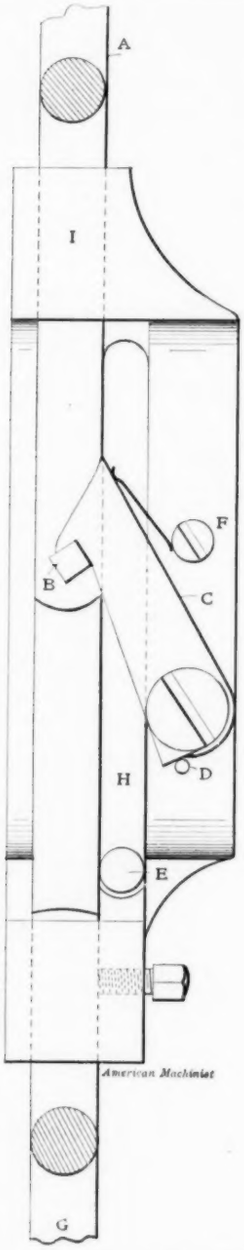
quirements and conditions of the machine on which it is to be used.

ERNEST J. LEES.

Cleveland, O.

Safety Device for Punch Press.

In the sketch *A* is a 3/8-inch round rod connected with the clutch on the punch press, and cut off and drilled crosswise at the end *B* for a round pin which is driven



SAFETY DEVICE FOR PUNCH PRESS.

in; the pin has a square head so that it can be turned one quarter way around when worn down. *C* is a spring pawl held in place with a shoulder screw and having a stop pin at *D*. *E* is a pin driven into the frame of the punch press. The whole mechanism moves up and down and this pin knocks out pawl *C* when the foot treadle has reached the end of its downward travel. The object is to make the operator push the treadle all the way down and he must then let go all the way before the pawl will catch again, thus avoiding a second stroke which is the real cause of injured fingers and spoiled work. *F* is a screw to hold either a flat or wire spring against the pawl. *G* is the lower part of the rod as cut off and shortened; with the screw it can be adjusted for height so as to knock out at the proper length of stroke.

This can be applied to any press that has no safety device, as all that is necessary is to cut off the regular rod and drill one hole for the square head pin. There is a slot at *H* in the casting *I* for pin *E* to travel in and the rod should be cut off at some place where it lies close to the frame so as not to require too long a pin. Part *I* is a loose fit on rod *A* and is held from turning by the usual loop above.

J. A. PETERSON.

A Ball Scoop—A Cheap Spring Bender.

Having a number of ball bearings to set up with 3/32 inch balls, I took the end of an umbrella rib with the edges turned

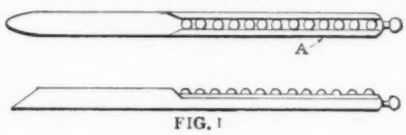


FIG. 1

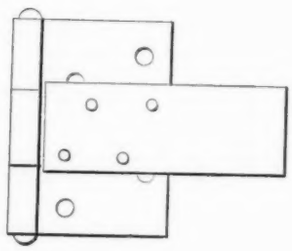


FIG. 2

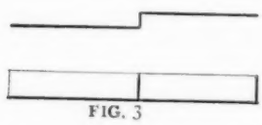


FIG. 3

A BALL SCOOP—A CHEAP SPRING BENDER.

over as at *A*, Fig. 1, to keep the balls from falling out and used it like a scoop to pick up and retain the correct number of balls, the surplus falling out when inverted.

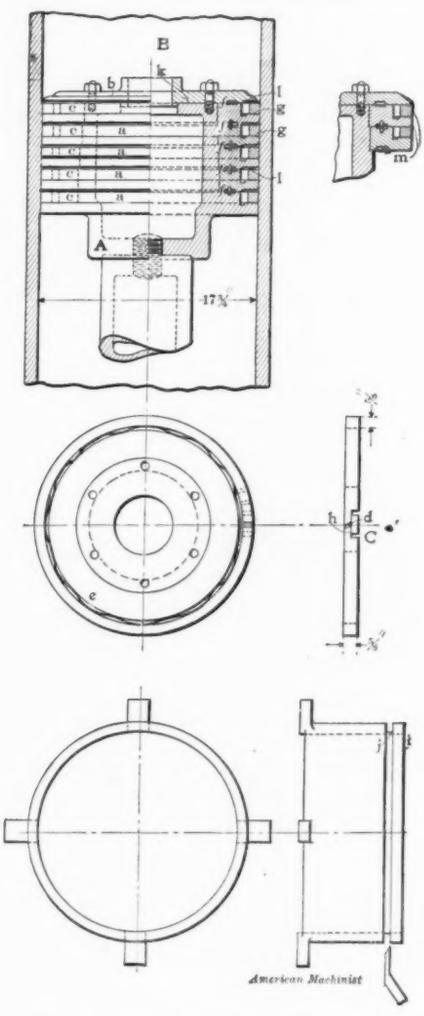
Another handy idea is shown in Fig. 2, and was used to bend pieces of spring steel while hot, to the shape shown in Fig. 3.

It was made by riveting pieces of steel to each side of an ordinary hinge.

MILTON BURGESS.

Making An Accumulator Piston.

While employed by a large manufacturing concern I had occasion to do the lathe work on quite a number of accumulator pistons, used in pumping engines for high duty. In the accompanying sketch *A* is the piston body, *B* the cylinder, *aa* the intermediate rings, *b* the follower, *cc* the piston rings. These rings are split as shown at *C*, and each one has a tongue *d*, and is made to bear against the inside walls of the cylinder by means of a band spring *c*. The bore of any of the intermediate rings is 1-64 inch smaller than that of the one immediately below; this is to allow the rings to be slipped into place with facility. The upper part of the cylinder, *B*, is connected with the air chamber of the water end of the pump, therefore the pressure on the piston varies according to the style and duty of the engines, and is greatest in pressure pumps.



MAKING AN ACCUMULATOR PISTON.

The piston must make the upper part

of the cylinder perfectly airtight, and faces *ff* of the body, intermediary rings and follower, and faces *gg* of the intermediate rings, and piston rings always had to be scraped. The tongues had also to be scraped against the inside of the rings and the face *h*. Considering the large size of the pistons (they ran from 12 to 21 inches diameter), it can be seen that it was expensive and tedious work.

We were given orders to do away with scraping on one piston 17¾ inches in diameter as an experiment, so I used extra care in doing the lathe work.

The intermediate rings were held in the chuck just tight enough to stay there, and a bar was used between the centers of the lathe with good sharp tools. All faces came true, smooth and parallel.

The lugs of the barrel from which I had to make the piston rings were carefully faced, then the casting was clamped to the face plate and turned and bored to the right dimensions. After facing the surface at *i* I cut down for the first ring, using a common parting tool but leaving the ring attached to the casting by a thin ring of metal at *j*. Then with a narrow, offset side tool, made for the purpose, the ring was faced at the other side and cut off finished. In this way all the rings were made perfectly true and their faces were parallel.

After finishing the body I put the intermediate rings in place and holding them there by means of three clamps, faced the top ring and body at *h* at the same time.

When the follower was bolted on the body the piston was brought back to me to be turned on the outside, and have its rings fitted in. The rings were, before, fitted loosely, there being about 1-64 inch clearance, and faces *l* of the intermediate rings were dished as shown in the sketch. In this piston I fitted the rings in, as shown at *m*, as nicely as I could, leaving just enough freedom to allow the band springs to force them against the inner wall of the cylinder. The only scraping done was in fitting the tongues to the rings.

When the accumulator was tested, an air pressure of 80 lbs. per square inch remained constant for several hours.

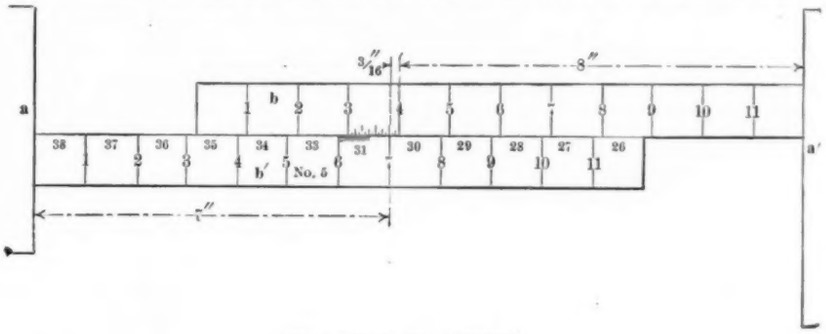
It took me longer to machine this piston than any before, but this was nothing compared with the time that was usually spent in scraping the work almost all over.

J. M. MENEGUS.

Two Scales as a Vernier.

Recently in the course of regular work I was up against it for an inside micrometer, to test a 14-inch snap gage that I was grinding up, but got over the difficulty nicely by using a Brown & Sharpe scale with No. 5 graduation, in combination with an ordinary 12-inch scale. The No. 5 scale has forty different graduations but the one that interested me was the inch divided into thirty-one parts; for 1/31 = 0.03225 inch and 1/32 = 0.03125 inch, so by placing the edges together and comparing the thirty-one divisions per inch on the one scale with the thirty-seconds on the other I had a vernier on which the number of thousandths indicated had to be added to the thirty-second nearest the inch division.

The reading is taken as follows: Starting on the No. 5 scale from the inch division of the thirty-one graduation, count from the end of the scale that is against the work toward the other, stopping when the lines on one scale coincide with the lines on the other, and add the result thus obtained to the value in thousandths of the first thirty-second past the inch line.



TWO SCALES AS A VERNIER.

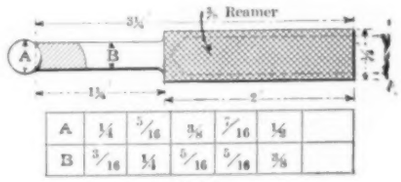
While this may seem a long operation it is far from it and when once the principle is conceived it is as easy as reading the vernier. On my own scale I have stamped with fine figures, 1 at the first ten, 2 at the second, to facilitate reading and also scratched these subdivisions on the edge of the scale as it is sometimes necessary to lay one scale on top of the other.

In the illustration *a*, *a'*, are the surfaces to be gaged, *b* is the regular scale with thirty-seconds along its entire edge, and *b'* the No. 5 with thirty-one graduations per inch at the point indicated. From the 7-inch line on the latter scale it is slightly more than 8-3/16 inches to *a'*; counting the number of thirty-firsts from the 6-inch until the lines coincide we get, say, 14, then 8-3/16 = 8.187 + .014 = 8.201 inches + 7 = 15.201 inches, which is the distance between the two surfaces.

H. BARCROFT.

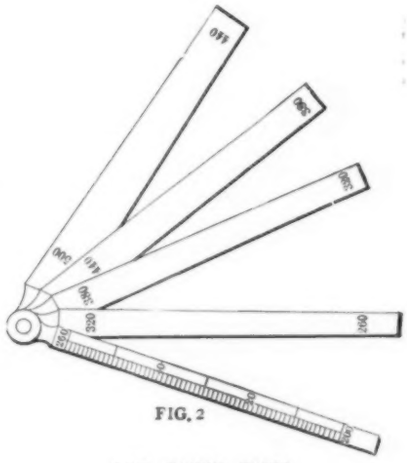
Two Handy Gages.

Allow me to bring before your notice two classes of gages which I have made, and which are useful in any toolmaker's kit. The style of gage in Fig. 1 is made by simply soldering a set of balls on some plain nurled holders cupped out at one end to suit the ball radius. The other end of the gage is lightened by drilling and reaming a hole as far down as possible, it being a reamed hole so that the gage can be placed on the end of a rod for convenience in measuring down in a recess. This gage has many advantages over a long plug gage, as it will not stick in the hole and it need not be placed in square. It will also give you the correct size for the length it can be entered into the hole, and the "feel" is of the nicest.



A	¼	5/16	⅜	7/16	½	
B	3/16	¼	5/16	5/16	⅜	

FIG. 1



TWO HANDY GAGES.

The balls are guaranteed to 0.0001 inch, and if you wear one small you can unsolder it and place another in position and have an accurate hardened and ground gage for 20 cents.

The gage in Fig. 2 is also very helpful for odd sizes and consists of 5 leaves running in a gradual taper from 0.2 to 0.5 inch. They are graduated and odd sizes can be obtained to a nicety. These gages are no doubt old but I have never seen them in any toolmaker's kit nor mentioned in any journal.

C——, England. NOMAD.

The De Laval steam turbine, originally designed and built in Sweden to the metric system, is made by Greenwood & Batley in Leeds, England, to the same system, but in Trenton, N. J., to the English system.

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The Swiss Adverse Trade Balance.

It is becoming increasingly evident that someone who does editorial work upon the *Consular and Trade Reports* needs to brush up a little regarding the principles that underlie foreign trade.

A recent issue of this interesting and valuable publication contains an account of Switzerland's industrial activity and prosperity, in which account it is truly said that "A little country that buys $239,000,000 worth of foreign products and sells goods valued at $170,000,000 from its own factories and farms is well worth studying."

The editor commenting upon this says, "It would be hard for the little republic to meet its advance trade but for the money furnished by visitors to its mountains and lakes."

Now as a matter of fact it is this very money or its equivalent carried to Switzerland by visitors that is the main cause of its so-called adverse trade balances. Not a great deal of foreign money is carried into Switzerland by visitors. Most of them carry letters of credit upon which they draw from Swiss banks, Swiss money, and this money, spent in Switzerland, is soon again in its banks. The amounts thus drawn become some form of indebtedness of foreigners to Switzerland or its people. They can not feed or clothe themselves with this indebetedness to them and so they buy with it foreign things that are of use to them.

It is thus seen clearly enough that the thing which the editor of *Consular and Trade Reports* thinks enables the Swiss people to meet its adverse trade balance is the thing which, more than anything else, creates and causes that "adverse trade balance." The fact is that the generally accepted notion about adverse and favorable trade balances is entirely wrong and by accepting it as right the editor of the Government publication referred to naturally falls into error whenever he comments upon commercial phenomena in which it is involved.

Count De Pambour.

The elaborate testing plant for locomotives installed by the Pennsylvania Railroad Company gives timely interest to an old and forgotten book, the memory of which has been resuscitated by *The Engineer*, of London, which was first published in French and subsequently, in 1836, translated and published in English by E. L. Carey and A. Hart, of Philadelphia. Both the original French and the translated American edition, especially the latter, are now extremely rare; but *The Engineer* has come into possession of one of the latter and publishes a reduced facsimile of its title page.

Our contemporary publishes an extremely interesting account of the contents of the book, and to this account we are indebted for the following facts:

The book appears to have been handsomely printed after the manner of its time, being a large octavo of 304 pages, illustrated by folding copper-plate engravings. De Pambour was the first to undertake any scientific experimental work upon the performance of the locomotive, and when the paucity of apparatus available in his time is considered, the thoroughness of his experiments and the excellence of his results are astonishing. In those days even pressure gages were unknown, and in calculations upon the locomotive it was always conveniently assumed that the pressure to which the safety valve was loaded represented the pressure within the boiler. Of course the application of the indicator to locomotives was then undreamed of, and to get at the first essential for his inquiries—the boiler pressure — De Pambour devised an ingenious little sentinel valve, the pressure on which could be adjusted in a moment, and by keeping this valve just on the point of blowing off, he obtained a very fair idea of the boiler pressure.

One of the points which De Pambour investigated was the resistance of railway trains, and his experiments on this subject were undoubtedly the first ever made that were in any way complete. Before his experiments an idea existed that the resistance on a level was 12 pounds per ton independent of the speed, except that with new passenger cars the resistance was taken to be 10 pounds per ton. He constructed a dynamometer for measuring the resistance, and while he had great difficulties from the vibration of the instrument, he confidently cut this figure down to 8 pounds per ton, or a little less. He was also the first to discover that the resistance per ton of a train diminishes with its length.

Having arrived at the resistance of trains, he proceeded to test the resistance of the engine. One of his efforts in this direction consisted in having the locomotive pulled along the tracks by two men—a spring balance being interposed between them and the locomotive. This is, of course, a curious commentary on the size of locomotives at that time, but he was not satisfied with it as a method, and proceeded to determine the point by reducing the pressure in the boiler until it was barely able to move the engine, and in this way he arrived at 12 7-10 pounds per ton as the resistance offered by the engine itself.

In connection with these experiments he devised the rule which is now in common use for obtaining the tractive power of an engine, namely, multiply the square of the diameter of one cylinder by the length of stroke, all in inches, and by the average effective pressure; divide by the diameter of the driving wheel in inches.

The book is a regular development of experimentation, analysis, and deduction,

and before finishing it he derived formulas by which can be determined the pressures and dimensions required to haul a given train. Prior to these experiments, no one knew how to proportion a locomotive for a given service except by following experience. Even the relations between boiler pressure and tractive effect were not understood.

These experiments were performed on engines of the Liverpool & Manchester Railway, 1835. A table of these engines is given, and it is interesting to note that the largest of the lot had cylinders 14x16 inches, and weighed 12 tons; the effective boiler pressure being given as 50 pounds.

In spite of the limitations due to the absence of apparatus, De Pambour's experiments were highly scientific in spirit and method. He accepted nothing as true until he had proved it and made every step sure before taking another, never making the fatal mistake of endeavoring to experiment on two variables at the same time. His work was that of a pioneer, and it was done with a degree of thoroughness which can only excite our unbounded admiration.

Baron de Hirsch Trade School.

We have received from the Baron de Hirsch Trade School, East 64th street, New York City, a copy of the twenty-first report of its superintendent J. E. G. Yalden. From the first class when 23 pupils graduated, to the twenty-first having 102 graduates, the school has had a very steady growth, the total number of graduates to date being about 1400. At the time the report was prepared it was expected that the twenty-second class would graduate about 120 pupils and it is estimated that in the near future there will be 260 graduates per year. Of the twenty-first class, 15 students graduated from the machinist department, 14 from the carpentry, 29 from the electrical, 26 from the plumbing and 18 from the painting departments. The average weekly wages received by the pupils of this class immediately after leaving school were as follows: Machinists, $9.17; carpenters, $10.67; electricians, $7.16; plumbers, $6.06; painters $7.71, the average for the entire group being $7.64. At the latest report the average rate of wages received by graduates of this class amounted to $9.30 per week.

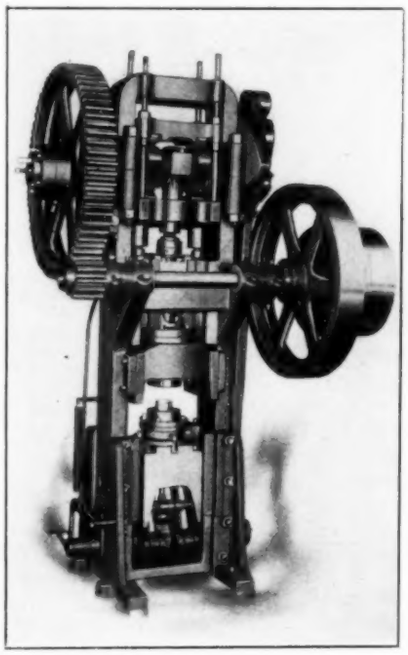
Statistics pertaining to three preceding classes show that at the present time the average wages received by the eighteenth class graduates are $14.11 per week; nineteenth class, $12.11 and twentieth class $9.60 per week. The equipment of the various departments has been considerably increased lately and the school can now accommodate at one time 25 machinists, 24 carpenters, 50 electricians, 45 plumbers and 25 painters. There were 250 names on file for admission to the class just entering

New Tools and Machine Shop Appliances.

A TRIPLE-ACTION DRAWING PRESS.

The illustration shows a drawing-press especially designed for drawing deep shells. The finished shell is to be seen in the center of the lower slide. In addition to the plunger, this press has two slides controlled by cams, each of these giving an independent dwell, thus permitting the making in one operation, work which has hitherto required two. This method does away with the annealing of first-operation shells as the second operation follows immediately after the first, and is practically a continuation of it, while the shell is still warm from the first draw.

The dies are so constructed that the second draw is at the bottom of the first-operation die. The punches are made so that the first-operation punch forms a



A TRIPLE-ACTION DRAWING PRESS.

shell around the second-operation punch. The two punches descend in unison till the first draw is made, the outside or first-operation punch then dwells, and the inside or second-operation punch moves on down, producing the second draw.

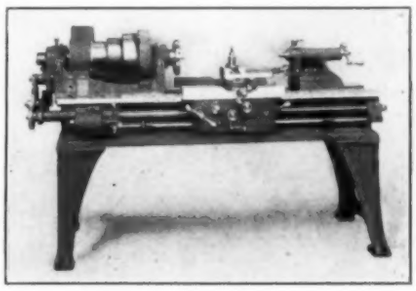
The press shown will receive a blank 11 inches in diameter, and a drawing punch up to 6 inches diameter. It will draw in depth and lift out up to 3 inches. Tin shells 3 inches diameter and 3 inches deep have been made on this press at one stroke. The weight of the press is 8000 pounds. It occupies no more room than the ordinary double-acting press of corresponding size for the second-operation shell.

The press may be set in an inclined position to allow the finished shell to fall off by gravity. This press is made by the E. W. Bliss Company, Brooklyn, New York.

A 16-INCH ENGINE LATHE.

The illustration shows a 16-inch lathe, with double back gears, for light or heavy work.

The cone has three steps, 11, 9¼ and 7½ inches diameter, respectively, for 3¼-inch belt. The single back gear has a ratio of 3 to 1, while that of the double



A 16-INCH ENGINE LATHE.

back gear is 9½ to 1. This combination, together with a two-speed countershaft, gives a range of 18 speeds for the spindle.

The spindle has a 1 5/16-inch hole through it. The bearings have ring oilers and are so constructed that in case of accidental damage they may be easily replaced, preserving the original alinement.

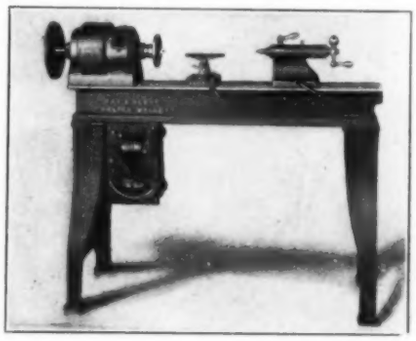
The feed is geared and gives six gradations, operated by means of a lever. By changing the gear on the lead screw, six other gradations of feed may be obtained.

This lathe can be supplied as shown, with either English or metric lead screw. Or with such extras as rapid-change gear device, oil pan, tank and pump.

It is built by the Springfield Machine Tool Company, Springfield, O.

A MOTOR-DRIVEN PATTERNMAKERS' LATHE.

The illustration shows a 10-inch motor-driven patternmakers' lathe. The motor is mounted directly in the headstock of the lathe. The field-magnet construction is such as to permit the use of a variable



A MOTOR-DRIVEN PATTERNMAKER'S LATHE.

speed motor having great variations of speed, in this case from 800 to 3000 turns per minute. The armature and commutator are mounted directly on the spindle. The rheostat is mounted on the bed of the lathe convenient for the operator. Thus the lathe, motor and rheostat are self-con-

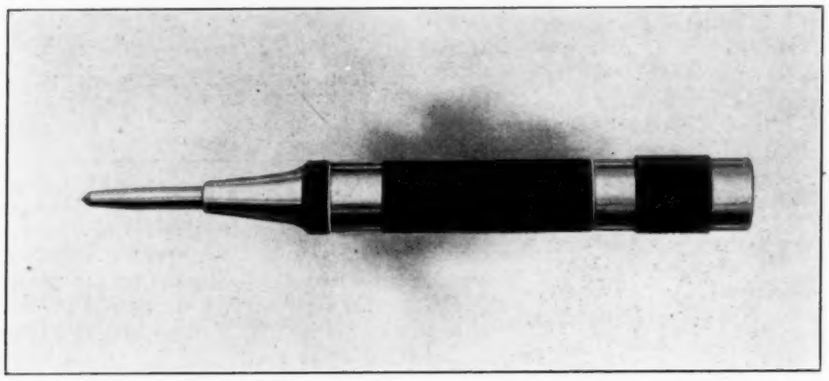
tained and may easily be installed in any place which can be reached by the necessary wires from the source of supply. The spindle is 1 5-16 inches diameter in the bearings, which are 2⅜ inches long; it has a 9-16-inch hole through it and is fitted with centers having Morse taper No. 2.

Beds are made 4, 6 and 8 feet long. The lathe with 4-foot bed takes 24 inches between centers and weighs 450 pounds.

These lathes are made by Fay & Scott, Dexter, Maine.

"AUTOMATIC" CENTER PUNCH.

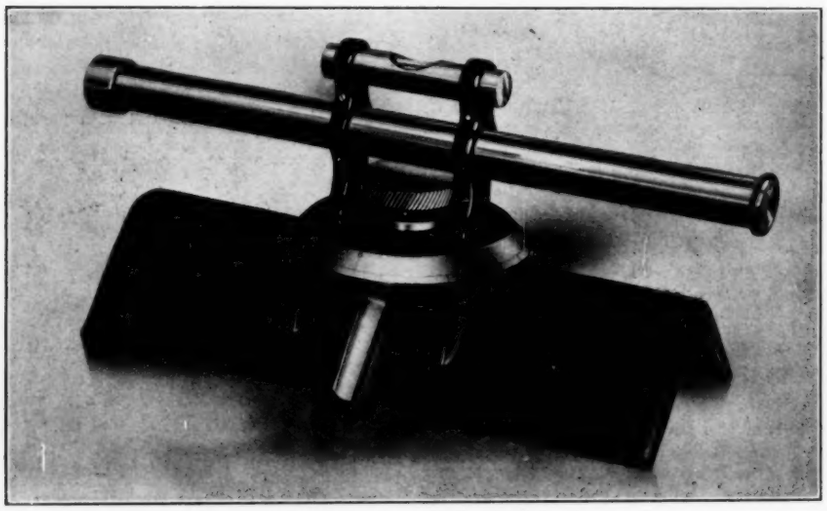
This punch is known as the "Automatic" and is used by simply placing the point at the required spot and pressing down upon the nurled handle; it is thus conveniently and quickly manipulated and one hand is left free to hold a magnifying glass when it is desired to locate exactly the point of intersection of lines drawn upon the work. The blow is struck upon the head of the punch proper by a cylindrical hammer or plug which slides in the hollow handle. This hammer is held by a catch, until compression of a spring in the nurled cap, as the tool is pressed down, overcomes the resistance of the catch and causes the punch to be given a smart blow. The force of the blow is regulated by adjusting the nurled cap, which is threaded to fit the end of the sleeve and may be turned with the fingers to put the required pressure upon the spring. The maker is the L. S. Starrett Company, Athol, Mass.



"AUTOMATIC" CENTER PUNCH.

A SHOP TRANSIT.

This instrument, which the inventor calls a shop transit, is constructed for locating and leveling machinery, shafting, etc. The body consists of an inverted V permitting it to be used on large or small shafts. A slit is cut through one side of the V-base in line with the center of the tool, for the purpose of making and locating marks on shafts. Over the center of the base is formed a circular seat, upon which is mounted a swiveling bracket, carrying the tube which contains the sights, with wires at one end crossing at the center of the field (similar to an engineer's transit), and above this tube is the level. The circular base of the bracket and the seat upon which it rests are graduated to indicate when the sights are parallel to the V-base, or at an angle of 45 or 90 degrees, either right or left. A thumb-nut is provided to lock the swiveling member when in position. The maker is H. B. Campbell, New Kensington, Pa.



A SHOP TRANSIT.

VARIABLE SPEED MOTOR.

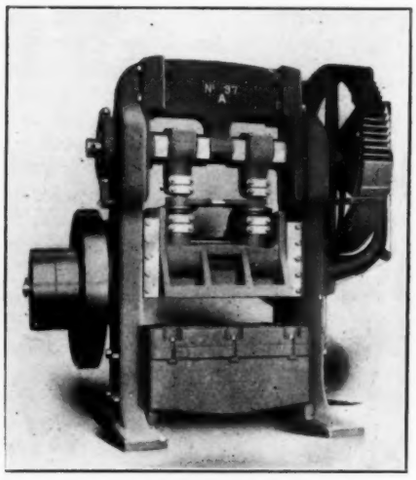
A line of direct-current motors having a speed range of 4 to 1 on a single voltage has been developed by the Westinghouse Electric and Manufacturing Company, of Pittsburg, the wide speed variations being obtained by field control.

These motors are exactly similar to the type S machines of the same concern except for the addition of auxiliary poles and coils. These are introduced in order to control the field form during the variation of field strength necessary to obtain so wide a range of speed. The cast-steel poles with machine-formed coils are placed midway between the main poles and securely bolted to the frame, the construction being simple and introducing no complications. The auxiliary field winding is connected in series with the armature, and therefore produces a magnetizing effect, which is proportional to the armature current. The auxiliary coils are placed close to the armature surface and their turns concentrated at that point, this arrangement applying the corrective influence of the auxiliary winding directly at the points where the distorting effect of the armature current is strongest. The motors are shunt wound, which gives a definite speed for each point of the controller, which is nearly constant for all loads. The motors are reversible without danger and without readjustment of the brushes, and, as the armature and auxiliary windings are connected permanently in series, it is only necessary to change the external connections to reverse the directions of rotation.

A PRESS.

The accompanying cut shows a heavy double-pitman power press for blanking. This size press was designed expressly for using special blanking and compound perforating and cutting dies of extra large size.

The frame is of the four-pieced pattern. The bed rests on a shoulder of the housing, and in addition to this is supported by four body-bound bolts on each side. The arch also bears upward against a shoulder on the housing, and in addition



A PRESS.

to this is supported by four body-bound bolts on each end. The pitman screws are fitted with bevel gears and pinions for quick adjustment.

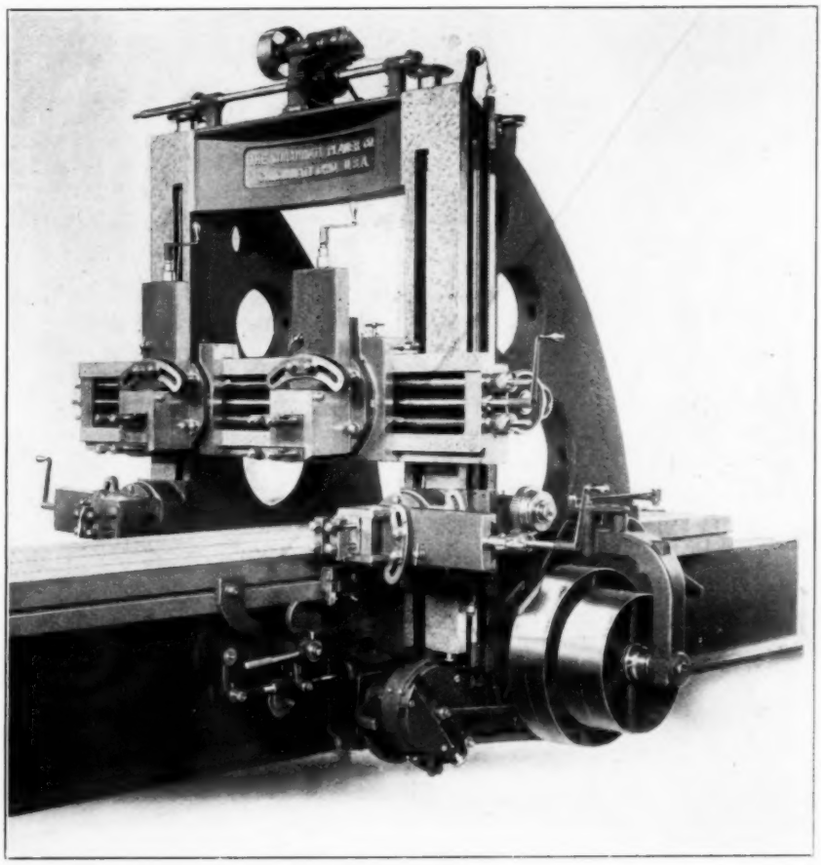
The press is double back-geared with a ratio of 30 to 1. The clutch gear runs loosely on the shaft directly on the outside of the main bearing.

Some of the measurements of this machine are as follows: Width between uprights, 61 inches; slide area, 32 inches front to back, 48 inches right to left; bed area, 48 inches front to back, 60 inches right to left; bed opening, 32 inches front to back, 48 inches right to left; capacity of press, about 600 tons pressure; weight, about 72,000 pounds.

This machine is one of 15 sizes now being put on the market by the Toledo Machine and Tool Company, Toledo, Ohio.

42-IN. TO 56-IN. EXTRA HEAVY PLANERS.

The 48-inch planer shown herewith represents a class of heavy forge type planers, which run in size from 42 to 56 inches. Among the features of the design are the square ends of the bed, and the increased length of bed in proportion to table, namely

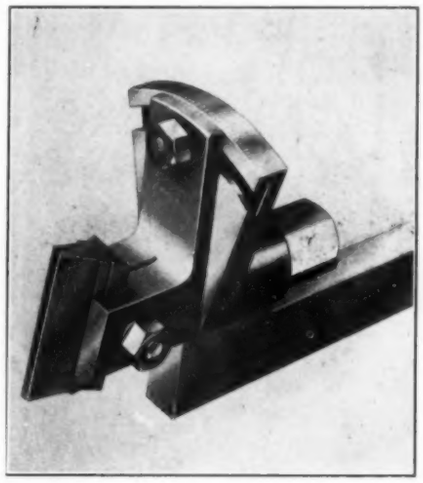


48-INCH EXTRA HEAVY PLANER.

1 2/3 instead of 1½, as previously made. The shaft boxes are ground and fitted to the bed with a bearing at each end. The housings are carried down to the floor and have been increased in some of their dimensions, and are arranged so that side heads may be attached at any time after the purchase of the machine. The table is increased in depth; dogs and complete shifting mechanism are provided on both sides. The quick return is 4 to 1. In order to avoid projecting corners on angular work, the lower ends of the tool-block and slide are made round, as can be seen in the half-tone. Taper gibs are provided and the slide is hung on ball bearings. The down feed has been increased several inches. The heads are made right and left, and an automatic tool-lifting device can be furnished at a small additional cost. The side heads are controlled by handles which travel up and down with them, convenient to the hand of the operator. The driving pulleys have been increased about ⅓ in width and are made with an oil reservoir, which insures their being oiled without constant attention. The pulley shaft is made ring-oiling and runs in Lumen bronze bearings. In the center of the arch, tying the housings together, can be seen the power elevating device, which is furnished with each machine. From its location a third bearing for the elevating shaft is obtained, likewise equal torsional deflection of the shaft on each side of the point of application of the power. The large gears and rack are made from semi-steel castings and the pinions from steel forgings. These machines can be built or readily changed to parallel drives; they are capable of any speed that the present high-speed steels will stand. They can be furnished to order with the patent two-speed countershaft or the patent variable speed-box of the manufacturers, the Cincinnati Planer Company, Cincinnati, O.

THREADING AND FORMING TOOL.

The half-tone illustrates a tool devised for holding cutters for U. S. Standard, square, Acme and other threads as well as radius and other forming cutters. As will be noted, the tool is carried by a swiveling block mounted at the front of the holder, which is provided with a graduated wing, the swiveling member

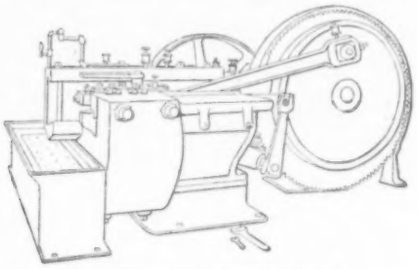


THREADING AND FORMING TOOL.

having a vernier by which settings may be made to 1/5 of a degree, or 12 minutes. A chart which accompanies the tool gives the angle at which the tool must be set for various pitches and diameters of work. The tools may be ground on the end without changing the shape, and as they are double-ended may be reversed in the holder when dull. The cutter is held bottom end up and the work is of course run backward, the cutter thus tending to seat the spindle and diminish vibration and chattering during the threading operation. The inventor is O. E. Simmons, 923 8th St., N. W., Washington, D. C.

A THREAD-ROLLING MACHINE.

The illustration shows one of a line of seven thread-rolling machines, with maximum capacities, for rolling threads on



A THREAD-ROLLING MACHINE.

blanks, from ⅛ to 1½ inches diameter.

In these machines the work may either be fed by hand or from a hopper. In hand feeding no special skill is required, as the

actual introduction of the blank between the dies is done by a feed slide at the proper time.

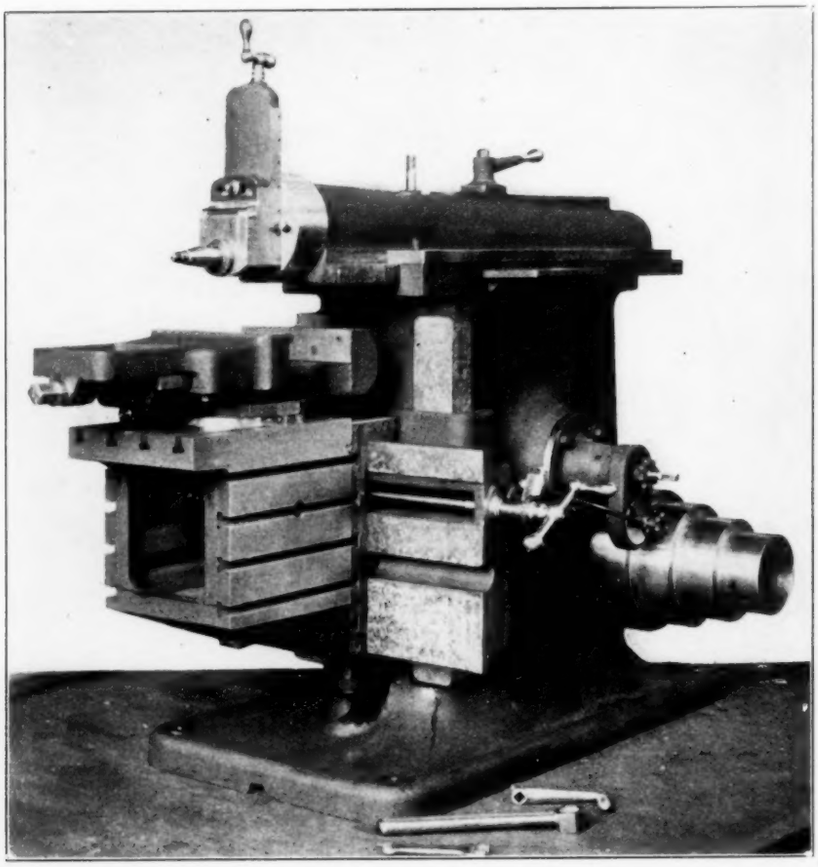
The work to be threaded, whether fed by hand or by the chute from the hopper, is automatically caught between two fingers. These fingers hold the blank straight and rigid, carry it and introduce it into the dies at the proper moment. This insures straight, accurate threads even on long work.

A positive knock-off follows behind the screw, sweeps over the stationary die, and just at the end of the stroke kicks over the corner of the moving die, thus preventing flat or badly shaped work sticking to the dies.

The machine may also be readily adapted to lettering, marking, fluting, nurling, etc., on solid cylindrical pieces; also for forming ratchet threads, gimlet points on wood-screws, lag-screws, hanger bolts, etc.

The oil pan catches the drip from all parts of the machine, which is thoroughly lubricated by means of a geared oil pump and suitable piping.

This machine is built by the Waterbury Farrel Foundry and Machine Company, Waterbury, Conn.



A 25-INCH BACK GEARED CRANK SHAPER.

A 25-INCH BACK-GEARED CRANK SHAPER.

The illustration shows a back-geared crank shaper designed for heavy duty.

The base extends out in front, is pan-shaped, with no corners to prevent getting oil and chips out easily. The ram is internally ribbed in such a way as to bring the greatest section under strain when it is out at its maximum reach. All adjustments may be made while in motion. The tool head can be swiveled to any angle and securely locked; the down-feed screw is provided with a micrometer collar reading 0.001 inch, and can also be furnished with automatic down and angular feed if desired. The elevating screw has ball thrust bearing and is telescopic. The cross-feed screw has automatic feed in either direction and a micrometer collar reading to 0.001 inch. The method of fastening the table to the cross slide is by means of three studs passing entirely through the top of the cross slide above the bearing on the cross rail; thus relieving the cast iron of tensile strains; in addition to these three studs at the top there are two bolts at the bottom. The vise jaws are faced with steel; the screw is entirely protected from chips and dirt and is subjected to tension and not compression strains; an index pin locks it at right angles or parallel with the ram, and it may be bolted to the top or either side of the table. A 4-inch shaft may be passed entirely through the column for key-seating, etc.

The cones are of large diameter, having four steps for wide belt, and in connection with the back gears give eight speeds to the ram; all shafts are provided with ring oiling devices. The counter shaft has ring oiling bearings in the hangers, the loose pulley is also self-oiling.

The maximum stroke is 26½ inches; vertical adjustment of the table 15 inches; cross motion of the table 32 inches; tool-block feeds in any direction, 9½ inches; cone pulley has four steps, 14, 11⅞, 9¾, 7⅝ inches respectively for 4-inch belt.

The floor space required is 56¾x136½ inches. Net weight, 4600 pounds.

This machine is built by the Springfield Machine Tool Company, Springfield, Ohio.

Personal.

Frederick R. Slater, formerly assistant electrical engineer for the New York City Railroad, has located at 100 Broadway, New York, for the practice of electrical engineering.

Howard K. McLean, for a number of years general superintendent of the Link-Belt Machinery Company, is now associated with the H. W. Caldwell & Son Company, of Chicago, Ill., as consulting engineer.

B. M. W. Hanson, for several years past the superintendent of the Pratt & Whitney shops at Hartford, Conn., has been appointed works-manager of the establishment, and H. C. Woglom, who has been Mr. Hanson's assistant as general foreman is now superintendent.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Wire and sheet metal working machinery and tools. Emmons Collins, Chicago, Ill.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Automatic machines designed and built. Geo. M. Mayer, M. E., 1131 Monadnock Block, Chicago, Ill.

"Dimensions of Pipe, Fittings, and Valves," 50c. "Lettering" 25c. Both 60c. Browning Press, Collinwood, O.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia.

Work wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

Any kind development work, special automatic machines, gas engines, automobiles, etc., designed. H. P. Moorees, M. E., E. E., 7 East 42nd St., New York City.

Wanted—To build special machinery, jigs, fixtures, punches, dies, power press tools and machine work. Accurate work guaranteed. Chas. S. Dexter, Attleboro, Mass.

Mechanical draftsmen—Several men, with good experience on gas engine work, for positions as detailers, designers, checkers and plant layout men. Salaries ranging from $100 to $135. Location Illinois. Engineering Agency, Monadnock Block, Chicago.

Mechanical draftsmen—For large manufacturing company in Wisconsin. Must be able to detail and design gas engines and blowing engines. Familiarity with blowing engines especially desirable. Engineering Agency, Monadnock Block, Chicago.

Wanted—Native of Great Britain to act as Sales Agent and to devote his entire time to representing in Great Britain the United States makers of a steel specialty used in manufacturing plants. State salary expected and give full particulars as to age, experience, reference, etc. Box 181, AMERICAN MACHINIST.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—1000 Steam and Water gauges at $1.00 each. Send for list to J. L. Lucas, 2 Fox St., Bridgeport, Conn.

Foundry, machine and boiler plant, $14,000. $6,000 will buy it. A rare chance. Address F. Palfrey, Macon, Mo.

For Sale—Two new electric traveling cranes. See advertisement page 87 this issue. Pawling & Harnischfeger, Milwaukee, Wis.

For Sale—Machine shop and foundry with an excellent opening for a boiler shop in connection. Situated in one of the best localities in the Southwest. For particulars address W. T. Taylor, 208 Cedar St., Oklahoma City, Okla.

Business Opportunities.

Partner wanted with capital to take active part in light manufacturing. Address Box 193, AMERICAN MACHINIST.

Partner for $7000 desired by successful machinery and tool business, five years old. Growing too large for present owner. $13,000 cash invested. Box 207, AMER. MACH.

M. E., owning patents on Rotary Pump or Blower of high efficiency and low cost to build would like to meet party with capital to build and market same. Machine has been tested and is no experiment. Box 206, AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Mechanical engineer-draftsman with ten years experience as designer, constructor and road engineer, experienced on electrical hoisting machinery and general machine work, would accept position in office or on the road with reliable company. Capable of taking charge. Good references. Now holding responsible position. Box 242, AMER. MACH.

ILLINOIS.

As Superintendent or toolroom foreman, 12 years experience, expert mechanic. Tools, jigs and dies a specialty, good designer and draughtsman, all-round mechanic, strictly sober. Box 225, AMERICAN MACHINIST.

MASSACHUSETTS.

Cost keeper and systematizer, several years experience in shop and general office work. Box 216, AMERICAN MACHINIST.

Mechanical Engineer, of good executive ability, capable of supervising design and construction of machines and tools, desires position. Address, Box 208, AMER. MACH.

Position of responsibility wanted by young man with broad experience manufacturing light hardware, and handling help. Practical mechanic, capable draftsman and designer, with inventive and executive ability. Box 215, AMERICAN MACHINIST.

NEW JERSEY.

Mechanical draftsman desires position, technical. Box 244, AMERICAN MACHINIST.

Master mechanic with 15 years experience in construction and repair work pumps, etc., in large factories. Box 179, AMER. MACH.

Superintendent or General Foreman. Young man of proven ability, energetic, capable of reducing cost and increasing output. Address "W," 209, AMERICAN MACHINIST.

Foreman blacksmith, up to date; has thorough knowledge of hand forging, steam trip and drop hammer work and treatment of all kinds of steel. Open for engagement by April 1. Reference exchanged. Box 241, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman wishes position. Address Box 240, AMERICAN MACHINIST.

Competent mechanical superintendent desires change. A-1 references, Box 237, AM. M.

General foreman, (36), successful in handling men and work to best advantage, varied experience in high-grade machinery; practical mechanic. Box 226, AMER. MACH.

Machine shop foreman, familiar with modern methods, and interchangeable manufacture; technical graduate and a hustler; desires change. Box 232, AMERICAN MACH.

Mechanical Engineer—Large experience with jigs and fixtures. Has letters from well known firms abroad and United States. Open to engagement as foreman. Box 198, AM. M.

Wanted—Position as works Superintendent. At present Assistant Superintendent with large Corliss Engine Co. Familiar with modern methods. Machinist by trade. Member of the A. S. M. E. Box 203, AMERICAN MACHINIST.

An educated Japanese mechanic, executive ability, experience in mining engineering and having extended business acquaintance in Japan; desires position as machinery salesman for Japan; Korea and China, age 29. Japanese, 243, AMERICAN MACHINIST.

Superintendent, hustling, aggressive and systematic, expert at tools, dies and fixtures, modern methods, straight manufacturing and interchangeable work, economical management, will show results at once, can get work out of help, will raise output and reduce costs. At liberty March 1. Box 231, AM. M.

A Mechanical Engineer with twenty years experience designing general special and automatic machinery and developing inventions, a practical knowledge of modern machine-shop practices, an inventor with a record of some thirty patent applications and familiar with patent law and proceedure, is open for engagement with reliable concern Box 239, AMERICAN MACHINIST.

Manager, 35 years old, open for position March 1st. New York City or within 1 hour's ride. Industrial economist, systematizer, complete accounting and business routineing. Cost methods and investigations. Technical and business education, 15 years practical experience. Competent to assume full charge of any manufacturing business in metal trades, or act as confidential man to President or etc. Best references. Address Manager Webster, 54 W. 107th st. New York City.

OHIO.

Position as foreman and designer by a tool-maker, jigs, gauges, compound dies experimental, etc. 20 years experience. Good references, fine work. Box 214, AMER. MACH.

PENNSYLVANIA.

Mechanical Engineer-Designer, wants permanent position, preferably with young concern needing works' manager, or head of mechanical end. Best references. Box 2615, Philadelphia, Pa.

Toolmaker machinist, jig designer, wants position, manufacturng, toolmaking, general work or partnership. 30 years, 4 years foreman. Now has charge 30 men. Box 233, AMERICAN MACHINIST.

Tool maker employed as salesman by machinery and supply house, wishes to represent manufacturer direct as local or traveling salesman, or demonstrator. Highest references. Address Box 245, AMER. MACH.

TENNESSEE.

Wanted—Position as Master Mechanic or foreman in a repair and job shop in the South. Experience in estimating as draughtsman and in designing. References. Address "C. W. R.," 224, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Designer familiar with natural and producer gas engine construction. Splendid opportunity for right man. Give references, age, experience and salary expected. Box 221, AMERICAN MACHINIST.

Wanted—A man for foreman of assembling department in adding machine factory. Must be a thorough mechanic, successful in handling men, and with full experience in this class of work. State age, nationality, experience and salary wanted. Address Box 222, AMERICAN MACHINIST.

Wanted—Assistant Superintendent for shops in machinery line, experienced particularly in gas engines and steam pumps; familiar with best machine tool work, piece work practice, etc. Growing position for man of ability and energy. Give references, experience, salary expected, etc. Box 220, AMER. MACH.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

INDIANA.

Wanted—One first-class wood pattern maker on automobile engine work. Address Box 182, AMERICAN MACHINIST.

Wanted—Foreman with experience in erecting four cylinder motors for automobile work. Good position in a well established Automobile Company for the right man. State experience, references, and salary wanted. Address Box 200, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Several machinists on small automatic machinery, tools and repair work. Permanent situation for competent men. A-1 factory in Worcester County. Box 213, AM. M.

Draftsmen—We have openings for three draftsmen who are well posted on mill construction. Vicinity of Boston. State age, experience in detail, and salary expected. Address "X Y Z," 238, AMER. MACHINIST.

Wanted—Eight tool makers for light machine and tool work. Up to date factory with modern equipment. Permanent position for right men. Works situated in Worcester County. State experience, age and wages expected. Box 211, AMERICAN MACHINIST.

Wanted—Six die makers for small punching, forming and embossing dies and tools, in first class shop with up to date machinery. Permanent situation if satisfactory. Factory in Central Mass. State age, experience and wages expected. Box 212, AMERICAN MACH.

MICHIGAN.

Draftsman wanted by a Detroit firm on jigs and fixtures for manufacturing gasolene engines and automobile parts on the interchangeable plan. Permanent position for a competent person. State age, experience, wages, nationality and full particulars. Box 186, AMERICAN MACHINIST.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Wanted—Foreman for press room. Must be A-1 on drawing and shell dies. Address giving experience. Box 229, AMER. MACH.

Tool Makers Wanted—First-cass men, with experience, on small spring motors preferred. Address, stating experience etc. Box 217, AMERICAN MACHINIST.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—Master Mechanic, competent to take charge of large general manufacturing plant, in New Jersey. First class references required. Address Mechanic, 794 Broad St., Newark, N. J.

Wanted—Mechanical Draughtsman for special machinery, jigs, tools. One with shop experience preferred. Address with reference, age, experience, and salary expected. Box 228, AMERICAN MACHINIST.

Wanted—Foundry Foreman to take charge of shop employing 70 men. One hour's ride from Phialdelphia; must be a capable man, qualified to handle men and familiar with modern appliances. S. B H., 192, AM. M.

Wanted—Three first-class machine hands, Horizontal Bar Mill hands preferred, no labor troubles here, steady work at good wages to competent men. Apply immediately. The Reeves Engine Co., Trenton, N. J.

Wanted—Die makers accustomed to small sheet metal work and Mechanical Draughtsmen accustomed to work on tools, fixtures and automatic machinery. Address stating experience and wages expected. C. S. 218, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman wanted for good jobs in New York. Box 201, AMERICAN MACH.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Mechanical draftsman. State age nationality, experience and salary wanted. Box 234, AMERICAN MACHINIST.

Machinists—Wanted first-class all-around machinists. Apply, stating wages wanted. Gifford-Wood Co., Hudson, N. Y.

Wanted—An experienced toolroom foreman familiar with tools for small and fine interchangeable parts. Address stating experience, and salary desired. Executive, 223, AM. M.

Toolmakers—Wanted immediately first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—Tool-maker or machinist who has had experience in the hardening and tempering of cutters, reamers, drills and other small tools. One who is thoroughly familiar with high-speed steels preferred. Box 235, AM. M.

Machinist wanted, used to small accurate work on engine lathe and shaper, manufacturing and tool work. State previous experience and wages expected. Working hours 54 per week. Address C. P. G., 210, AM. MACH.

Wanted—For Gray Iron Foundry of 8 to 10 tons daily capacity, an energetic and capable foreman. Must be up-to-date in every respect. Address in own writing, giving reference and stating salary desired. Box 227, AMERICAN MACHINIST.

Wanted—Capable energetic young men of mechanical ability and some education, with good habits, as assistants to foremen in a hardware factory, located in the country, employing 500 hands. Send full particulars with photograph and references to Box No. 89, Kenwood, N. Y.

Pattern maker, or other person familiar with wood patterns, to systematize large pattern loft, making complete lists, marking and locating patterns systematically; several months' work; likely to lead to good permanent position; location Greater New York. State experience and references. Address Box 205, AMERICAN MACHINIST.

The Works of the Russell, Burdsall & Ward Bolt & Nut Co., are located at Port Chester, N. Y., a delightful residential town 26 miles from New York on the shores of Long Island Sound. They have places open for a number of first-class all-round machinists. Their business is rapidly increasing, they are constantly adding to their equipment and require additional force to build new machines and take care of existing equipment. Steady work is assured for intelligent, capable and reliable men. References and qualifications required.

OHIO.

Wanted—An experienced storeroom keeper in machine shop of a plant employing one thousand men. Address Box 236, AM. MACH.

Foreman Wanted—Practical mechanic who has had experience manufacturing machines and machinery. Splendid chance for advancement for hardworker. Box 230, AM. MACH.

A company employing about 250 men and building a line of machine tools wishes an assistant superintendent. The position requires a practical mechanic of executive ability and who has a faculty for handling men. Give references, state experience and name salary desired. Box 167, AMER. MACH.

Wanted—First-class man to take charge of designing of up to date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work—The Blaisdell Machinery Co., Bradford, Pa.

Wanted—Experienced operator for Sellers Tool Grinder. State fully past experience and wages required. Box 219, AMER. MACH.

Wanted—A foreman capable of taking charge of machine shop equipped principally with light and heavy turret lathes, adapted for pneumatic tool work. Must understand design of turret tools, jigs, etc., and rapid duplication of parts. Box 199, AMER. MACH.

The Monotype Company maintains a school to train young men to meet the constantly increasing demand for operators of its type casting and composing machine. These operators have done so well that it receives more applications for places than can be filled. In making selections these qualifications carry most weight: common sense, typefoundry experience, printing office experience, automatic machinery experience. Full particulars will be furnished to inquirers who furnish the same informaton about themselves. The Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Wanted—First-class draftsmen on special tools, jig and fixture work for light high-grade machinery. Apply to The Taft-Peirce Mfg. Co., Woonsocket, R. I.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Large concern building excavating and railway machinery wants to correspond with first-class mechancal draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Wanted—Graduate mechanical engineer, with shop and drawing room experience, to take position in our draughting room, to learn our business, with view of representing us as sales agent in large city. Curtis & Co. Mfg. Co., St. Louis, Mo.

FOREIGN.

Wanted—First-class superintendent in one of the best and longest established sewing machine factories in Germany. Must be entirely familiar with the manufacture of special machines and appliances, and all interchangeable parts. Applicant must have held similar position in America, be either German or speak German fluently. Position permanent if satisfactory. Address, giving age and full information, K. D. 6305, au Rudolf Mosse, Koln, Germany.

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Aftercoolers, Air

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Wilmarth & Morman Co., Grand Rapids, Mich.

Arbors, Expanding Milling

Cochrane-Bly. Co., Rochester, N. Y.

Architects

Dodge & Day, Philadelphia, Pa.

Auctioneers

Shaw & Co., New York.

Automatic Machinery

Matchless Cigar Lighter Mfg. Co., New York.
National Machinery Co., Tiffin, Ohio.

Ball Bearings

See Roller Bearings

Barrels, Steel

Kilbourne & Jacobs Mfg. Co., Columbus, Ohio
Lyon Metallic Mfg. Co., Chicago, Ill.

Barrels, Tumbling

Globe Machine & Stamping Co., Cleveland, O.

Bars, Boring

Beaman & Smith Co., Prov., R. I.
Cleveland Twist Drill Co., Cleveland, O.
Mathews, Hugh, Kansas City, Mo.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.
Underwood & Co., H. B., Philadelphia, Pa.

Bars, Boring Cylinder

Underwood & Co., H. B., Philadelphia, Pa.

Belt Dressing

Cling-Surface Co., Buffalo, N. Y.
Dixon Crucible Co., Jos., Jersey City, N. J.
Shultz Belting Co., St. Louis, Mo.

Belt Filler

Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.

Belt Gouges

Hulbert Co., Winsted, Conn.

Belt Lacing Machine

Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.

Belting, Leather

Davis Machine Co., W. R., Rochester, N. Y.
Main Belting Co., Phila., Pa.
Montgomery & Co., New York.
Schieren & Co., Chas. A., New York.
Shultz Belting Co., St. Louis, Mo.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Bending Machinery, Plate

Hilles & Jones Co., Wilmington, Del.
Nagara Machine & Tool Works, Buffalo, N. Y.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Bending Machines, Hydraulic

Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Bending Machines, Power
Bertsch & Co., Cambridge City, Ind.
Bethlehem Foundry & Mach. Co., So. Bethlehem, Pa.
Boynton & Plummer, Worcester, Mass.
Long & Allstatter Co., Hamilton, Ohio.
National Machinery Co., Tiffin, Ohio.
Niles-Bement-Pond Co., New York.
Swaine Co., Fred J., St. Louis, Mo.

Bending Tools, Hand
Estep & Dolan, Sandwich, Ill.
Wallace Supply Co., Chicago, Ill.

Bicycle Parts
Standard Welding Co., Cleveland, Ohio.

Blanks, Nut and Screw
Whitman & Barnes Mfg. Co., Chicago, Ill.

Blocks, Chain
See Hoists, Hand.

Blowers
American Blower Co., Detroit, Mich.
Am. Gas Furnace Co., N. Y. City.
Buffalo Forge Co., Buffalo, N. Y.
Chicago Flexible Shaft Co., Chicago, Ill.
General Electric Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Roth Bros. Co., Chicago, Ill.
Sturtevant Co., B. F., Hyde Park, Mass.

Blue Print Machines
Buckeye Engine Co., Salem, O.
General Electric Co., New York.

Boilers
Davis Machine Co., W. P., Rochester, N. Y.
Struthers-Wells Co., Warren, Pa.

Bolt and Nut Machinery
Acme Machy. Co., Cleveland, O.
Boynton & Plummer, Worcester, Mass.
Brown Co., H. B., Easthampton, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Harrington & Son Co., Edwin, Philadelphia, Pa.
Landis Mach. Co., Waynesboro, Pa.
Lang Co., G. R., Cincinnati, O.
National Machinery Co., Tiffin, Ohio.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Reliance Machine & Tool Co., Cleveland, Ohio.
Standard Machinery Co., Bowling Green, Ohio.
Standard Engineering Works, Ellwood City, Pa.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach Co., Waterbury, Conn.
Mass.
Webster & Perks Tool Co., Springfield, O.
Wells Bros., Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass

Bolts, Coupling
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bolts and Nuts
Cleveland Cap Screw Co., Cleveland, O.
National-Acme Mfg. Co., Cleveland, O.

Bone for Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Books, Mechanical
American School of Correspondence. Chicago, Ill.
Audel, Theo. & Co., New York.
Frost, Edward J., Jackson, Mich.
Henley Pub. Co., Norman W., New York.
Hill Pub. Co., New York.
Modern Machy. Publishing Co., Chicago, Ill.
Tulley & Co., Henry C., St. Louis, Mo.
Wiley & Sons, Jno., New York.

Boosters
C & C Elec. Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley, G. I. Elec. Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach Tool Co., Cleve., O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mch. Tool Co., Franklin Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co. Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Ridgway Mach. & Tool So., Ridgway, Pa.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.

Boxes, Tote
Lyon Metallic Mfg. Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleve., O.

Broaching Machines
Burr & Sons, Jas. T., Brooklyn, N. Y.

Bulldozers
National Machinery Co., Tiffin, Ohio.
Prentiss Tool & Supply Co., New York.
Toledo Machine & Tool Co., Toledo, Ohio.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Montgomery & Co., New York.

Calipers
Athol Machine Co., Athol, Mass.
Mass. Tool Co., Greenfield, Mass.
Montgomery & Co., New York.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Works, Boston, Mass.

Carborundum
See Grinding Wheels.

Case-Hardening
Rogers & Hubbard Co., Middletown, Conn.

Castings, Brass
Phosphor Bronze Smelting Co., Phila., Pa.

Castings, Die Molded
Franklin Mfg. Co., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Fuchs & Lang Mfg. Co., New York.
Massey Mach. Co., Watertown, N. Y.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
U. S. Foundry & Sales Co., South Norwalk, Conn.

Castings, Motor
Barnes & Son, T., Brooklyn, N. Y.
Harrison, H. N., St. Paul, Minn.
Steffey Mfg. Co, Phila., Pa.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.
Deek, Chas., Bayonne, N. J.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
National Machine Co., Hartford, Conn.
Phoenix Mfg Co., Hartford, Ct.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Boston, Mass.
Cullman Wheel Co., Chicago, Ill.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Morse Chain Co., Trumansburg, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co, R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Ct.
Goodell-Pratt Co., Greenfield
Horton & Son Co., The E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford, Conn
Modern Tool Co., Erie, Pa.
Montgomery & Co., New York.

Chuck Drills—*Continued.*
Morse Twist Drill & Mach Co., New Bedford, Mass.
Niles-Bement-Pond Co.,New York.
Oneida National Chuck Co., Oneida, N. Y.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Westcott Chuck Co., Oneida, N. Y.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co, Greenfield, Mass

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Gisholt Mach. Co., Madison, Wis.
Horton & Son Co., The E., Windsor Locks, Conn.
Montgomery & Co., New York.
Niles-Bement-Pond Co., New York.
Oneida National Chuck Co., Oneida, N. Y.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Westcott Chuck Co., Oneida, N. Y.

Chucks, Split
Hardinge Bros., Chicago, Ill.
Rivett Lathe Mfg. Co., Boston, Mass.
Westcott Chuck Co., Oneida, N. Y.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. Y.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
General Elec. Co., New York.
Stanley G. I. Elec Mfg. Co., Pittsfield, Mass
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.

Clutches, Friction
American Tool & Machine Co., Boston, Mass.
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila, Pa
Eastern Machinery Co., New Haven, Conn.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York
Patterson, Gottfried & Hunter, Ltd., N. Y.
Reeves Pulley Co., Columbus, Ind
Wood's Sons, T. B., Chambersburg, Pa.

Clutches, Magnetic and Electrical
Cutler-Hammer Clutch Co., Milwaukee, Wis.

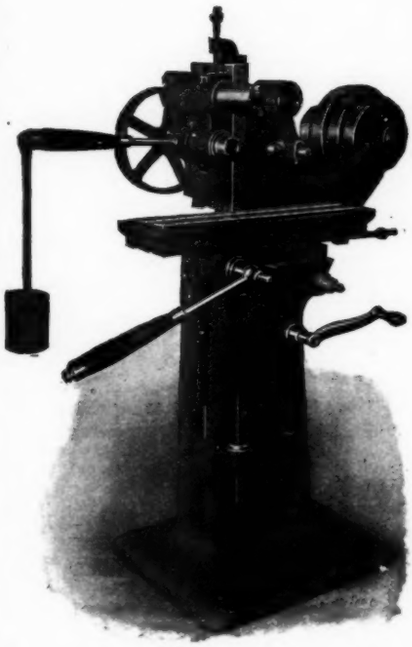
Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

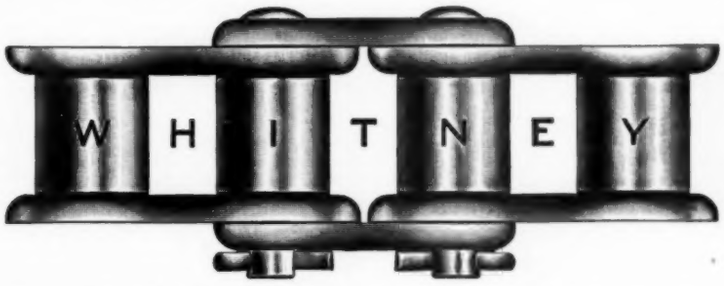
Coils
Standard Welding Co., Cleve., O

Compounds, Pipe Joint
Dixon Crucible Co., Jos., Jersey City, N. J.

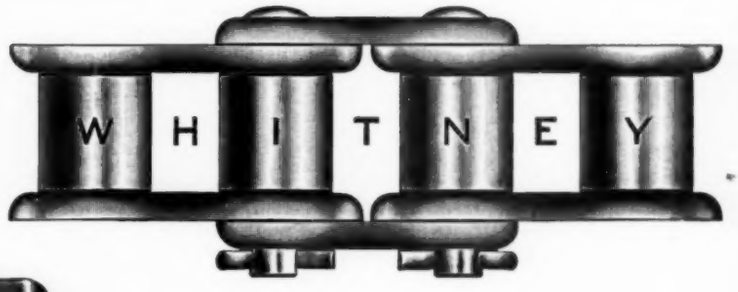
Compressors, Air
Blaisdell Mchy. Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
Fulmer, Chas. F., Plainfied, N. J.
General Pneumatic Tool Co., Montour Falls, N. Y.
Hoermann, A. E., New York.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Mietz, August, New York.

"WIZARD" Chains and Sprockets—Patented

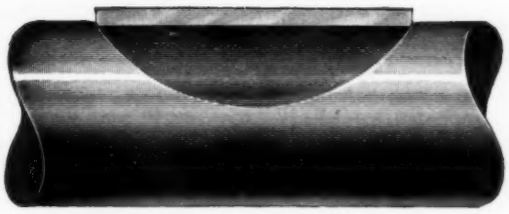




1906 Model "Whitney" Detachable Roller Chains—Patented



Block Chains



"Woodruff" Patent Keys

Three Popular Specialties

"Whitney" Chains
Hand (feed) Milling Machines
The Woodruff Patent System of Keying

THE WHITNEY MFG. COMPANY

HARTFORD, CONN., U.S.A.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., Great Britain. Schuchardt & Schutte, Germany, Austria, Holland, Russia and Scandinavia. Fenwick, Freres & Co., France, Belgium, Italy, Switzerland, Spain and Portugal

Compressors, Gas

Ingersoll-Rand Co., New York.

Condensers

Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.

Conduit, Interior

Sprague Elec. Co., New York.

Cones, Friction

Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work

Blanchard Mach. Co., Boston, Mass.

Controllers and Starters, Electric Motor

Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Clutch Co, Milwaukee, Wis.
General Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Coping Machines

Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Correspondence Schools

See Schools, Correspondence.

Cotters

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores

Morse Twist Drill & Mach Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters, Machinery

Durbrow & Hearne Mfg. Co., New York.
Veeder Mfg. Co., Hartford, Conn.

Countershafts

Almond Mfg. Co., T. R., Brooklyn, N Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co, R. K., Cincinnati, O.

Countershafts, Friction

Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing

Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach Co., Madison, Wis.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels

Franklin Mfg Co., Syracuse, N. Y.

Coupler, Hose

Ingersoll-Rand Co., New York.

Couplings, Shaft

Almond Mfg. Co., T R., Brooklyn, N. Y.
Caldwell & Son Co, H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Davis Machine Co., W. P., Rochester, N. Y.
Link-Belt Engineering Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter Ltd., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Woods Sons, T. B., Chambersburg, Pa.

Cranes

Alliance Machine Co., Alliance, Ohio.
Brown Hoisting Mach. Co., New York.
Byram & Co., Detroit Mich.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
Frevert Mfg. Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.

Cranes—*Continued.*

Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa...
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg Co., New York.

Cranes, Portable

Franklin Portable Crane & Hoist Co., Franklin, Pa.
Nicholls, Wm. S., New York.

Crank Pin Turning Machine

Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts

Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles

Dixon Crucible Co., Jos., Jersey City, N. J.

Crushers

Ingersoll-Rand Co., New York.
Link-Belt Engineering Co., Philadelphia, Pa.

Cupolas, and Ladles, Foundry

Byram & Co., Inc., Detroit, Mich.
Obermayer Co., S., Cincinnati, O.
Paxson Co. J. W. Phila., Pa.
Stevens, F B., Detroit, Mich.

Cups and Covers, Oil

Bay State Stamping Works, Worcester, Mass.
Besly & Co. Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Winkley Co., Detroit, Conn.

Cut Meters

Warner Instrument Co., Beloit, Wis.

Cutters, Milling

Adams Co., Dubuque, Iowa
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Hardinge Bros., Chicago, I..
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M, Boat, Gauge & Drill Works, Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol. Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines

Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown &Sharpe Mfg. Co., Providence. R. I.
Davis Machine Co., W. P., Rochester, N. Y.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlburt-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools

Armstrong Bros Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
Goodell Mfg. Co., Greenfield, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Cutting-off Tools—*Continued*

Western Tool & Mfg. Co., Springfield, Ohio.

Diamond Tools

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Dickinson, Thos. L., New York.
Francis & Co., Hartford, Conn.

Dies, Sheet Metal

American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W.. Brooklyn, N. Y.
Globe Machine & Stamping Co., Cleveland, Ohio.
Kent & Co., Edwin R., Chicago,
Marchant, Geo. F., Chicago, Il.
Niagara Machine & Tool Works, Buffalo, N. Y.
Swaine Co., Fred J., St. Louis, Mo.
Toledo Machine & Tool Co., Toledo, Ohio.

Dies, Sub-Press

Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening

Errington, F. A. New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Modern Tool Co., Erie, Pa.
Pratt & Whitney Co., Hartford, Conn.
Reliance Machine & Tool Co., Cleveland, Ohio.
Swaine Co., Fred J., St. Louis, Mo.

Dowel Pins

Winkley Co., Detroit, Mich.

Drawing Boards and Tables

Queen & Co., Phila., Pa.

Drawing Materials

Alteneder & Sons, Theo., Phila., Pa.
Queen & Co., Phila., Pa.

Draughting Machines

Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers

Ingersoll-Rand Co., New York.

Drilling Machines, Bench

American Watch Tool Co., Waltham, Mass.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Dwight Slate Machine Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
McGeorge & Sons, Cleveland, O.
Patterson Tool & Supply Co., Dayton, Ohio.
Pratt & Whitney Co., Hartford, Conn.
Sloane & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler

American Tool Wks. Co., Cin.. O.
Aurora Tool Works, Aurora, Ind.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Multiple Spindle

American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co, W. F. & John Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O
Dwight Slate Machine Co., Hartford, Conn.
Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach. Co., New York.
Hardinge Bros. Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
Moline Tool Co., Moline, Ill.

Drilling Machines, Multiple Spindle —*Continued.*

McCabe, J. J. New York.
National Machine Co, Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Drilling Machines, Portable

Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester. Mass.
Gem Mfg. Co., Pittsburg, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.
Stow Mfg. Co., Binghamton, N. Y.

Drilling Machines, Radial

American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Drilling Machines, Turret

Niles-Bement-Pond Co., New York.

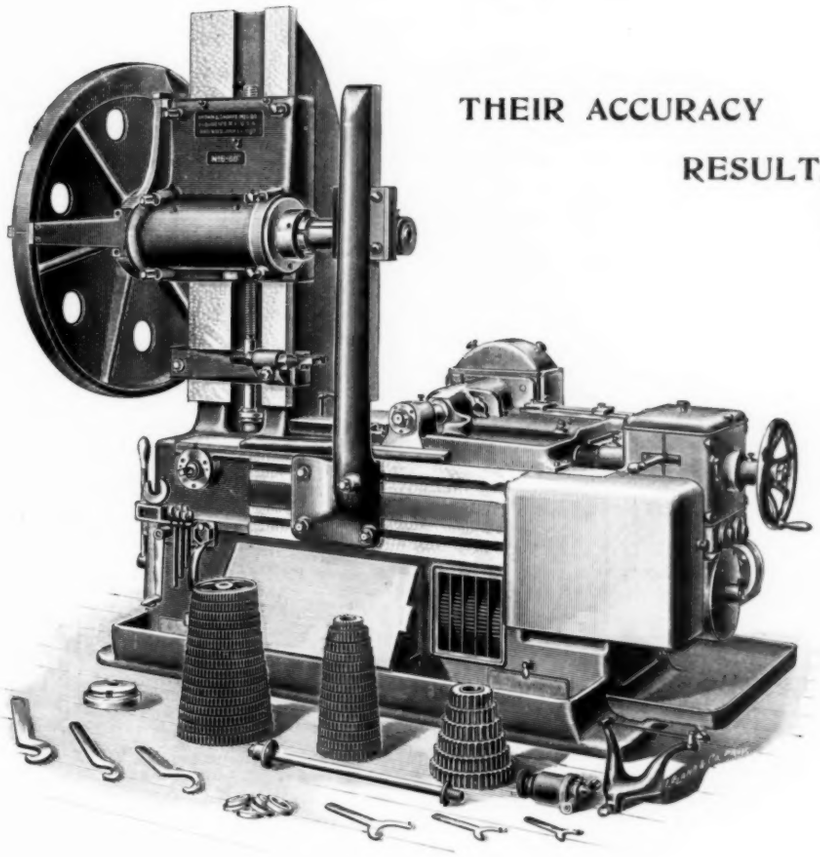
Drilling Machines, Upright

American Tool Wks. Co., Cin.. O.
Aurora Tool Works, Aurora, Ind.
Baker Bros., Toledo O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co, W. F & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd, John, Dundas Ont., Canada.
Boynton & Plummer, Worcester, Mass.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Mach. Tool Co., Cincinnati. O
Davis Machine Co., W. P., Rochester, N. Y.
Dwight Slate Machine Co., Hartford, Conn.
Fairbanks Co., New York.
Fenn-Sadler Mach. Co., Hartford. Conn.
Fosdick Mach Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill
Knecht Bros. Co., Cincinnati, Ohio.
Marshall & Huschart Mchry. Co., Chicago, Ill.
McCabe, J. J., New York.
Mechanics Machine Co., Rockford, Ill.
Morse Twist Drill & Mach. Co., New Bedford. Mass.
National Machine Co., Hartford, Conn.
New Haven Mfg Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Sloane & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U.S.A.

B. & S.
Automatic Gear Cutting Machines.



THEIR ACCURACY
RESULTS IN
ECONOMY.

ACCURACY FEATURES.

Indexing Mechanism. Positive. Operation without shock. Independent of feed and speed of cutter.

Index Wheel. Accurately cut. Of large diameter in proportion to diameter of work.

Special circulars, describing these machines in detail, sent upon request.

Drills, Center
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J T., Providence, R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
Cleveland Pneu. Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail
Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O

Drills, Ratchet
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers, Boat, Gauge & Drill Wks., John M., Gloucester City, N. J
Standard Tool Co., Cleveland, O

Drills, Rock
Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co, Madison, Wis.

Drying Apparatus
American Blower Co., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Dust Collectors
Allington & Curtis Mfg. Co., Saginaw, Mich.

Dynamos
C & C Elecric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin, O.
Northern Elec. Mfg Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F, Hyde Park, Mass.
Triumph Elec. Co., Cincin, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Dynamotors
Sprague Elec. Co., New York.

Electrical Supplies
Clark, Jr. & Co., Jas., Louisville, Ky.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
Electro Dynamic Co, Bayonne, N. J.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros. Co., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery
American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O
Clark, Jr. & Co., James, Louisville, Ky.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.
Roth Bros. Co., Chicago, Ill.

Elevators
Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co,. Edwin, Philadelphia, Pa.
Link-Belt Engineering Co., Philadelphia, Pa.
Morse, Williams & Co., Phila., Pa.

Emery Wheels
See Grinding Wheels.

Emery Wheel Dressers
Desmond-Stephan Mfg. Co., Urbana, O.
Francis & Co., Hartford, Conn.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Reed Mfg. Co., Erie, Pa.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.

Enclosures, Tool-room
Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical
Dodge & Day, Philadelphia, Pa.
Roedder, O. C., Karlsruhe, Germany.

Engineers, Electrical
Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile
Franklin Mfg. Co., Syracuse, N. Y.
Olds Gasoline Engine Works, Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasoline
Automatic Mach. Co., Bridgeport, Conn.
Blaisdell Machinery Co., Bradford, Pa.
Brown-Cochran Co., Lorain, O.
Columbus Mach. Co., Columbus, O.
Foos Gas Engine Co., Springfield, Ohio.
Jacobson Mach. & Mfg. Co., Warren, Pa.
Mathews, Hugh, Kansas City, Mo.
Mietz, August, New York.
New Era Engine Co., Dayton Ohio.
Olds Gasoline Engine Wks., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Oil
Mietz, August, New York.

Engines, Steam
American Blower Co., Detroit, Mich.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery
Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads
Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery
Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube
Nicholson & Co., W. H., Wilkesbarre, Pa.

Extinguishers, Fire
Badger & Sons Co., E. B., Boston, Mass.

Fans, Electric
Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York..
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust
American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers
Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps
Barnett Co., G & H., Phila., Pa.
Hammacher Schlemmer & Co., New York.
Heller Bros. Co., Newark, N. J.
Montgomery & Co., New York.
Nicholson File Co., Prov., R. I.
Richheim & Co., E. P., New York.

Filing Machines
Cochrane-Bly. Co., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Grant Mfg. & Mach. Co., Bridgeport, Conn.
Henry & Wright Mfg. Co., Hartford, Conn.

Fillets, Leather
Cleveland Fillet Co., Cleveland, Ohio.

Flexible Shafts
Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Stow Mfg. Co., Binghamton, N. Y.

Forges
Boynton & Plummer, Worcester, Mass.
Bradley & Son, C. C., Syracuse, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Burke Machinery Co., Cleveland, Ohio.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
National Machinery Co., Tiffin, Ohio.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop
Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
Lang Co., G. R., Cincinnati, O.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic
Wyman & Gordon, Worcester, Mass.

Forgings, Steel
Baldwin Steel Co., New York.
Boker & Co., Hermann, N. Y.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
McInnes Steel Co., Corry, Pa.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Furnishings
Adams Co., Dubuque, Iowa.
Byram & Co., Inc., Detroit, Mich.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B F., Hyde Park, Mass.

Fuel Economizers
Sturtevant Co., B. F., Boston, Mass.

Furnaces, Annealing and Tempering
American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Furnaces, Enameling
American Gas Furnace Co., New York.

Furnaces, Gas
Am. Gas Furnace Co., N. Y. City.
Chicago Flexible Shaft Co., Chicago, Ill.
Westmacott Co., J. M., Providence, R. I.

Furnaces, Melting
American Gas Furnace Co., New York.

Furniture, Machine Shop
Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters
Sturtevant Co., B. F., Boston, Mass.

Gauges, Recording
Bristol Co., Waterbury, Conn.

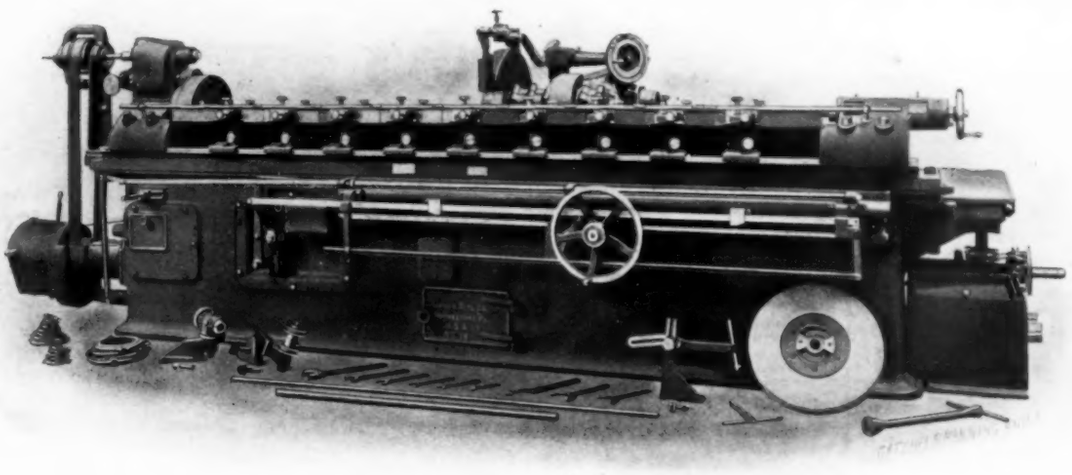
Gauges, Standard
Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Mass. Tool Co., Greenfield, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers, John M., Boat, Gauge & Drill Works, Gloucester City, N. J.
Slocomb Co., J T., Prov., R. I.
Starrett Co., L S., Athol, Mass.

Gauges, Steam
Davis Machine Co., W. P., Rochester, N. Y.
Lunkenheimer Co., Cincinnati, O.

Gear Cutting Machinery
Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Dwight Slate Machine Co., Hartford, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Matchless Cigar Lighter Mfg. Co., New York.
Morse, Williams & Co, Phila., Pa.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sloane & Chace Mfg. Co., Newark, N. J.
Turley, Harvey G., St. Louis, Mo.
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co, D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

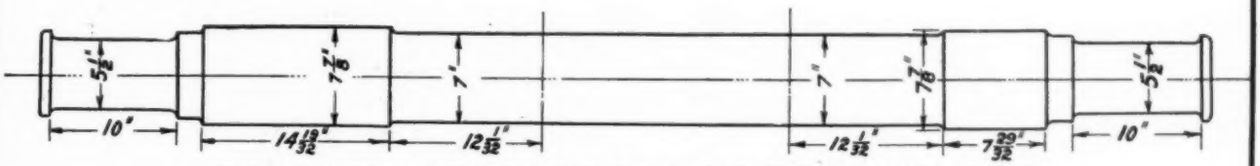
Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston Mass.
Brown & Sharpe Mfg Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Eickemeyer Mfg. Co, Yonkers, N. Y.
Fawcus Mch. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Foote Bros. Gear & Machine Co., Chicago, Ill.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Hardinge Bros., Chicago, Ill.
Harrington, Son & Co., Edwin, Philadelphia, Pa.



No. 18 Plain Self-Contained Grinding Machine, 12" swing, 120" between centers.

MOTOR CAR BUILDERS:

Here's a specimen of grinding done on a "Landis" No. 18 Grinder.



Motor Car Truck Axle. All dimensioned surfaces ground. 1 32" diameter removed: time 50 minutes.

WE call your attention to the fact that in this machine the grinding wheel, or fixed weight, travels while the work carrying table remains stationary and rigid. Hence there is a constant regular duty imposed upon the traversing and reversing mechanism instead of an irregular strain as when the part being traversed is a varied weight. This principle insures accuracy at points of reversing, and constant lubrication of the ways, reducing their wear to the minimum. Also note that the geared headstock gives the machine a powerful work drive on all work speeds, and that this "Landis" is equipped with a Variable Traverse Speed Changing Device of a new and novel design. Variation of speed between extremes is obtained by moving a lever—no changing of gearing, clutches or belts. We are grinding specialists and build grinders adaptable for every manufacturing purpose. What are your requirements?

Landis Tool Company, Waynesboro, Pa., U. S. A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, Ohio, and 233 Monadnock Blk., Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C.W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Milan, Paris and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Can.

Gears, Cut—*Continued.*
Horsburgh & Scott Co., The, Cleveland, O.
James, D. O., Chicago, Ill.
Massey Mach. Co., Watertown, N. Y.
Morse, Williams & Co, Phila., Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Syracuse Raw Hide Mfg. Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Turley, Harvey G., St. Louis, Mo.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Wks., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Rawhide

Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mch. Co., Pittsburg Pa.
Gould & Eberhardt, Newark, N. J.
Horshburg & Scott Co., Cleveland, Ohio.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Syracuse Raw Hide Co., Syracuse, N. Y.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
James, D. O., Chicago, Ill.
Morse, Williams & Co, Phila., Pa.
Nuttall Co., R D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Generating Sets

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Boston, Mass.
Triumph Elec. Co., Cincinnati, O.
VanDorn & Dutton, Cleveland, Ohio.
Walcott & Son, Geo. D., Jackson, Mich.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Gem Mfg. Co., Pittsburg, Pa.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mch. Tool Co., Cin., O.

Grinders, Center—*Continued.*
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Rivett-Dock Co., Boston, Mass
Stow Mfg. Co., Binghamton, N. Y.

Grinders, Cock

Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Dayton Machine & Tool Works, Dayton, O.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., New York.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., The, Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk

Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Iroquois Mach. Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill

Heald Mch. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co, Providence, R. I.
Greenfield Mach. Co., Greenfied, Mass.
Heald Mch. Co., Worcester, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Piston Ring

Heald Mach. Co, Worcester, Mass.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Heald Mach Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Dwight Slate Machine Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.

Grinders, Tool—*Continued.*
Harrington, Son & Co., Edwin. Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Landis Tool Co., Waynesboro, Pa.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Grinding and Polishing Machines

Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders' Iron Foundry, Providence, R. I.
Burke Machinery Co., Cleveland, Ohio.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Fairbanks Co., New York.
Gilmore Electric Co., South Boston, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Mach. Co, Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Machine Co., Cin., O.
Iroquois Mach. Co., New York.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Montgomery & Co., New York.
National Machine Co., Hartford, Conn.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Patterson Tool & Supply Co., Dayton, Ohio
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett-Dock Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Star Corundum Wheel Co., Detroit, Mich.
Stow Mfg. Co., Binghamton, N. Y.
Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Webster & Perks Tool Co., Springfield, O.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagar Falls, N. Y.
Davis Machine Co., W. P., Rochester,
Diamond Mach. Co., Prov., R. I.
Hampden Cor. Wheel Co., Brightwood, Mass.
National Corundum Wheel Co., Buffalo, N. Y.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, N. Y.

Grinding Wheels—*Continued*
Safety Emery Wheel Co., Springfield, O.
Star Corundum Wheel Co., Detroit, Mich.
Superior Corundum Wheel Co., Waltham, Mass.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames

Athol Machine Co., Athol, Mass.
Cleveland Stone Co., Cleveland, Ohio.
Niles-Bement-Pond Co., New York.

Gun Barrel Machinery

Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E W., Brooklyn, N. Y.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Merrill Bros., Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New
Toledo Machine & Tool Co., Toledo, Ohio.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Cleveland Pneu. Tool Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, Ohio.
Ingersoll-Rand Co, New York.
International Steam Pump Co., New York.
Niles-Bement-Pond Co., New York.

Hammers, Power

Bradley & Son, C. C., Syracuse, N. Y.
Fairbanks Co., New York.
Niles-Bement-Pond Co., New York.
Patterson Tool & Supply Co., Dayton, Ohio.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn

Hammers, Steam

Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Bradley & Son, C. C., Syracuse, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Handles, Machine Tool

Schacht Mfg. Co., Cincinnati, Ohio.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Handles, Screw Plate

Standard Welding Co., Cleve., O.

Hangers, Shafting

Cresson Co., Geo. V., Phila., Pa.
Fairbanks Co, New York.
Hyatt Roller Bearing Co., Harrison, N. J.
Link-Belt Engineering Co., Philadelphia, Pa.
Wood's Sons, T. B., Chambersburg, Pa.

Heaters, Feed Water

Sturtevant Co., B F., Hyde Park, Mass.

Heating and Ventilating Apparatus

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B F., Hyde Park, Mass.

Heating Machines

Am. Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Designing a Boring Mill.

BY ENTROPY.

I have been trying lately to learn how to design machinery by reading books on that subject, but without getting much satisfaction. There seems to be a noticeable difference between the designing of the books, and designing "as she is done" in actual life, and it occurred to me that some of the younger readers might like to get an idea of how designs are evolved. I have just been asked to get out sketches for a boring mill of 6 feet swing to take 48 inches under the cross rail. Now I do not know anything about boring mills, so if I go over the reasoning which I took to get at a design, it will be about the same course that any man would take to go at a machine new to him, and also knowing about how such things are gone at I hope to get out a design that will not be entirely impossible.

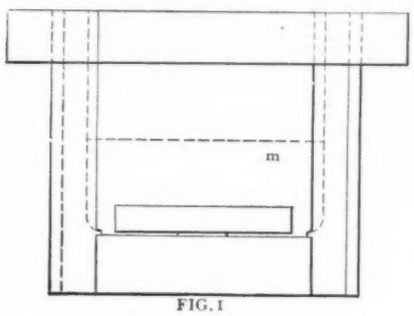


FIG. 1

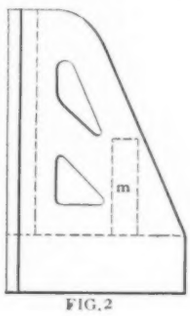


FIG. 2

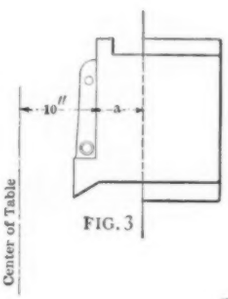


FIG. 3

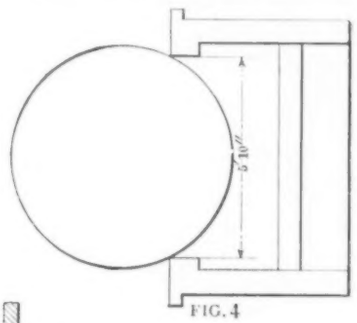


FIG. 4

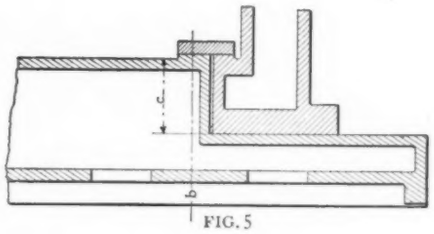


FIG. 5

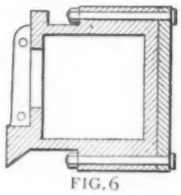
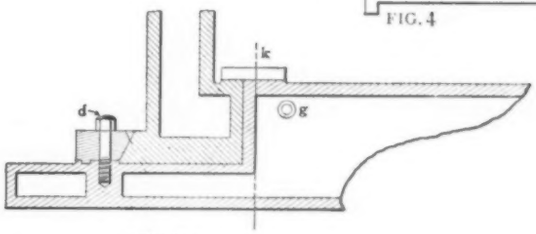


FIG. 6



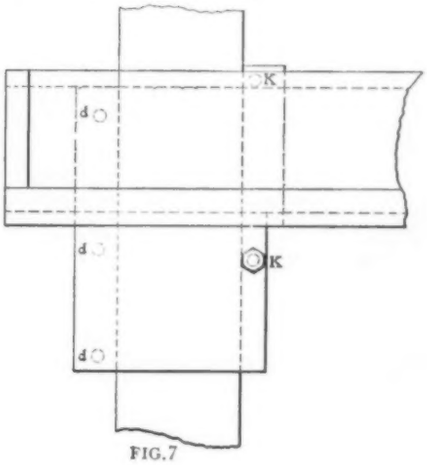


FIG. 7

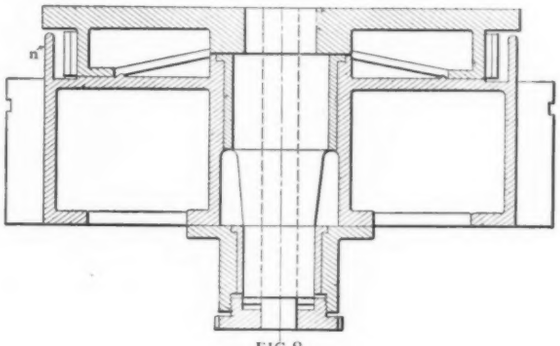


FIG. 8

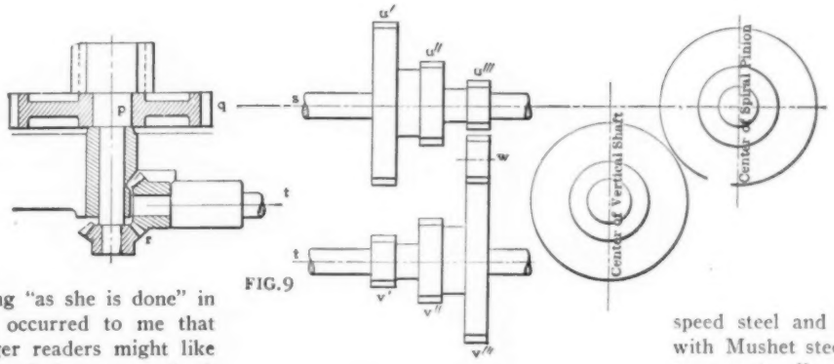


FIG. 9

BORING MILL DETAILS.

THE TABLE.

The first point that I considered was the diameter and thickness of the table. For the diameter I took 60 inches because I have seen a 72-inch planer with a table 60 inches wide which looked about right, and a planer is only a boring mill for work of an infinite radius instead of a short one (reason No. 1). For the thickness I first assumed that the driving-gear (spur, external) should be 1½ pitch diametral and 6 inches face. I assume this because a 38-inch lathe of my acquaintance has a 3-pitch gear with a 4½ inches face, and as we want this mill for hard work with high speed steel and the lathe stood up well with Mushet steel, I think this pitch will turn out all right (reason No. 2). Since this width of face will be a part of the depth of the table, we need only a little more than enough to allow for a good T slot. Brown & Sharpe's largest cutter for T slots makes a slot 1 inch wide with a total of 2 inches depth, so we

will make our table 9 inches deep in all, which will be ample for stiffness (reason No. 3).

HIGHT OF TOP OF TABLE FROM FLOOR.

This mill is to go where it cannot very well be set down into the floor bodily. If we have a hole through the floor for the tail end of the spindle that is all we can get. To get a good depth of bed we must put the table up high, and to keep the table low and convenient we must make the bed shallow. We can compromise on 18 inches for depth of bed, which with ½ inch clearance, will put the top of the table 27½ inches above the floor. Looking over the advertising pages of the AMERICAN MACHINIST seems to justify this as good judgment (reason No. 4).

WIDTH OF POSTS.

The next thing to consider is the width of face of the posts. This width should be enough to hold the tool up to its work without too much chatter even on high work. As far as these stresses are concerned, the width of post should be as great as the depth of bed, but the bed has other things to hold beside the side pressure, so we will make the width of faces 15 inches. This is much in excess of the usual limit, but what little I have seen of boring mills and planers convinces me that a little extra iron here will pay good dividends to the user (reason No. 5).

WIDTH OF CROSS RAIL.

This should be the same as the depth of bed. The cross rail must withstand everything that the bed does except support the weight of the table and work, and the cross rail is much more poorly supported. We will make it 18 inches deep over all (reason No. 6).

A GENERAL VIEW.

We will now lay out roughly to scale free-hand, a sketch of a front view of what we have gotten so far with the cross rail clear up, and see how it looks—Fig 1. It looks and is stubbed, but it does not looks so spidery as lots of boring mills do. It will have been noticed that neither boring mill nor planer builders, as a class, like to have their machines photographed head on any more than a girl with a snub nose likes to see her profile. As this view does not look bad, we will sketch Fig. 2 for a side view of the post. The width of the post in the planer business is apt to be made equal to the width or hight of work which the machine can take in. In this case it would be either 4 or 6 feet, so we compromise on 5 feet (reason No. 7).

The outlines of the post shown are due to Professor Sweet (reason No. 8) except that the diagonal cross bar is copied from Woodward & Powell's planers. I notice that others have begun to copy this feature, so we will adopt it here, although we might not wish to be the first to copy directly (reason No. 9).

The distance which the face of the post will set back of the center of the table will depend on how heavy the boring bars, heads and cross rail are. On the one hand, the heavier these parts are, the stiffer they will be; but the more they overhang the posts, the more springy their connection. In this case there will have to be another compromise, but at the start we will have to guess at it and then change it later, if necessary. We will allow for the thickness of cross rail in front of the posts 6 inches (*a* Fig. 3). From this surface to the center of the table allow 10 inches more (reason No. 10). This puts the face of the post 16 inches back of the center of the table, and a sketch to scale, Fig. 4, shows us that we can place the posts only 70 inches apart and still get 74 inches swing, which will allow enough for rough castings (reason No. 11). We shall have to move the left-hand post over about 3 inches to allow for something that will be explained later.

THE CROSS RAIL.

The cross section of the cross rail is borrowed from Bullard (reason No. 12) with a slight change to disguise it, but the principle remaining the same, that the guiding and driving of the head shall be concentrated at the lower edge, and the entire depth of the rail shall be used to carry the pressure of the cut. The lead screw and rod are placed as shown. The top of the cross bar does not overhang the rod and screw because there is no object in shielding the rod or screw in this case, and it would weaken rather than strengthen the rail to do it (reason No. 13).

The section between posts is to be a hollow square box with only enough opening to support the core and get the sand out through. This section is adopted from Professor Sweet (reason No. 14). The cross section is kept uniform through its length because the principal stress to be contended with is torsion and the points at which the stress is to be applied vary all the time. When the heads are at any one point there is undoubtedly surplus metal at other points, but it looks as queer to me to see a bellying cross rail as it does to see a bellying lathe bed (reason No. 15).

Fig. 5 shows a horizontal section through the cross rail and posts. Bolts at *b* fasten the rail to the posts on the inside so that all torsional stress is transmitted directly to the posts (reason No. 16). This is necessary to get the advantage of the square section. The width at *C* is 10 inches to make the main part of the cross rail square in cross section. It seems rational to believe that if a box form is good a square box will have the most strength for a given weight of any rectangular form (reason No. 17).

Fig. 6 shows a section down through the binder bolts which run through ears which project enough above or below the body of the cross rail so that the nuts can be gotten at without moving the heads along. (reason No. 18). The size of these bolt depends on the strength of the man behind the wrench and its length, and the length of the wrench depends in a general way on the size of the machine. That is, a workman has a sort of indefinite sense of how big a wrench he expects to see on a certain size tool. If he expects to see an 18-inch wrench on a 6-foot planer or boring mill, and we give him a 6-inch, knowing that it will be sufficient for the place, it will make no difference to him, and until he has had the wrench welded out to meet his idea or put a piece of pipe on it, he will not be satisfied. Now an 18-inch wrench looks just about right to me for a machine of this size (reason No. 19), and an inch and a quarter bolt looks just right to fit an 18-inch wrench, so we will make it that size. This is confirmed by looking up the wrenches listed by one of the leading drop-forge companies, so 1¼ inches it is (reason No. 20).

Fig. 7 shows the construction at the left hand end of the cross rail due to Professor Sweet (reason No. 21). The cross rail is extended downward, and is fitted to the post so as always to be square with it. Only one elevating screw is used, at *g*, between the vertical guides and at the center of gravity of the whole. The objection may be raised that there is no possible way to adjust the bar to keep it parallel with the top of the table. There is no need of adjustment any more than there is on the carriage of a lathe, nor as much, for the slide is subject to wear only in the comparatively rare intervals when the cross rail is raised or lowered, and once set right it should stay right. We never think of making the arm of a radial drill adjustable (reason No. 22). We will make the length of the guide 3 feet because more seems like a waste of material, and less seems liable to cramp and make it difficult to raise and lower (reason No. 23). Studs *d d d* are to hold the gib in place, and once adjusted are to be let alone. Binding is all to be done with bolts *k*, the same as at the other end. Screw *g* will be hung from the top of the left-hand post, but may just as well be driven from one end as the other. We will probably find it most convenient to drive it from the lower end. Being hung in this way the screw will always be in tension, which for a slender screw is always desirable (reason No. 24).

The form of the cross rail and its fastening render a tie piece at the top unnecessary, as it ties the two posts together wherever it may be; but, since the bed is shallow, and to make one post stiffen the other, we will add to Figs 1 and 2 a cross brace at *m*. Even if this brace is cored out pretty thin, it will help stiffen all these parts to a great extent (reason No. 25). Elevating screw *g* is on the left-hand side of the machine so that the operator who will habitually be on the right-hand side will loosen the binder bolts there, go over to the left-hand side and loosen the binder bolts on that side, run the rail up or down by a lever on that side, tighten up the

binders, and returning, tighten up the right-hand binders and arrive back where he started without any lost steps (reason No. 26).

TABLE AND SPINDLE BEARING.

We will have an annular bearing as large as will go inside the gear, and a spindle with two straight bearings like a lathe. The large bearing for a 72-inch lathe would be about 12 inches in diameter. I do not think that 12 inches is large enough for a 72-inch lathe for high-speed steel work, but with the vertical spindle the weight of the running parts and the work is all taken off this bearing, so for our purpose it will probably be all right (reason No. 27). If the length of the bearing is 12 inches and the thickness of the hub of the table is 6 inches. we will have 11½ inches from the floor to the bottom of the large bearing. If we bolt a bottom bearing about 9 inches diameter by 10 inches long under the bottom of the bed projecting down through the floor, it will give us a total length of 37½ inches, which would be rather short for a lathe, but for a boring mill will probably be all right, considering the use of the annular bearing (reason No. 28). It is necessary to make the bearings of the spindle straight since we wish to lift it off the annular bearing when running fast. This makes it necessary to have some means of taking up side wear. This ought not to be great since the pressure on the tool to feed it is all that will come on it. A plain split box like the usual lathe box will be all sufficient, and since it is down out of sight where it is hard to get at and adjust, it probably will run for years with no perceptible wear. I would not make it impossible to get at this bearing, but I would be careful not to make it too accessible.

THE DRIVE.

Since we are using a 1½ pitch gear a 15-tool pinion will be 10 inches pitch diameter. We ought not, for the sake of future wear, to use less than this number of teeth (reason No. 29). To determine the number of teeth in the gear on the table we will refer to Fig. 8. The guard at n should be ½ inch under the edge of the table, ¾ inch thick and have at least ¾ inch clearance on the drawing. The addendum of the gear will be ⅔ inch, so the pitch diameter of the gear must be as much as $2(\frac{1}{2}\times\frac{3}{4}\times\frac{3}{4}\times\frac{2}{3})$ inches less than the diameter of the table, or 54⅔ inches, which will allow 82 teeth or a ratio of practically 5½ to 1 (reason No. 30). The limiting speeds suggested are 40 feet per minute on 3 inches diameter to 20 feet per minute on 72 inches diameter, or from 53 to 1 revolution per minute of the work. The driving pinion will run from 270 to 5½ revolutions. A constant belt speed drive is the only allowable thing nowadays. As we do not want to back the machine for thread cutting, we will violate this condition so far as to make a two-speed countershaft and make the driving pulley large enough to transmit all the power that we can use. The remaining speeds we will get by means of gears. If we use 2:1 as the ratio between steps for the gear speeds and put the two counter speeds in a ratio of 1.41 : 1 ($\sqrt{2}$: 1) we will have less variation between speeds than is usual, but none too little (reason No. 31). On this basis, and with 5½ revolutions per minute to start from, we get 5½ - 11 - 22 - 44 - 88 - 176 for the slow countershaft speeds and multiplying by 1.41 we get 7¾ - 15½ - 31 -62 - 125 - 250 for the fast countershaft speeds. The last falls below the required speed, but as our customer is not very strenuous about it we will leave it as it is (reason No. 32) though a little use of the slide-rule would give us just what we are after. This change in the high speed only reduces the the cutting speed on a 3-inch hole to 37 feet per minute.

This arrangement gives us six speeds to take care of with gears, or if we back gear we will have the equivalent of three open belt speeds and three back geared. The ratio of back gears in any case will be the ratio of the first speed above to the fourth, or the second to the fifth, etc., or 8:1. Since our driving shaft must be horizontal, and the spindle and pinion shaft are necessarily vertical, we will take advantage of this unfortunate state of affairs by using the gear scheme of Fig. 9, in which p is the vertical shaft with the driving pinion carrying a spiral gear (ratio 8:1 to its pinion) at q and a miter gear at r. The two shafts s and t are to be located far enough apart, so that a nest of gears $u\ u\ u$ and $v\ v\ v$ can be placed on each, and have room enough between so that a pinion w can be moved all through between them without touching either, so that it can be brought in mesh with any one of the six gears. Suppose w is driven from some outside source at 250 revolutions per minute, and that v' is the same size as w, and that v'' is twice the size and v''' four times the size of w, then the vertical shaft will be driven at 250, 125 and 62½ revolutions per minute according as w is brought into mesh with each one in turn. Now if u''' is the same size as w, and u'' twice and u' four times the size of w we will get for speeds of the vertical shaft, keeping the ratio of the spiral gears (8:1) in mind, 31, 15½ and 7¾ revolutions per minute. It remains only to find a way of driving w and bringing it into mesh successively with the desired gear, and do it in a way not covered by patents, and this I will leave to the imagination of the reader.

It will also be desirable to have the spiral pinion splined to its shaft so that it will be free to move in one direction (as drawn it will be to the right) when being driven by the large gear. It will then move along and out of the mesh with the gear and leave the upper shaft standing still when using high speeds. There will not be any great loss of power if we let the lower shaft run all the time, its highest speed being 31 revolutions per minute. This scheme of having the pinion slide endwise I copy from the barring mechanism of an English engine that was at the World's Fair at Chicago in '93 (reason No. 33). We cannot figure the strength of these gears by any known rule, for they will be subject to some intense shocks at times when being shifted, if the machine is taking a cut or if the table is running fast, the latter probably being the greatest. If they are 3 pitch, and we do not use any gear under 15 teeth, the pitch diameters will run 5, 10 and 20 inches each, and as we evidently have room enough for these sizes of gears we will use that pitch. In any case we will use steel castings. Our only basis for wishing to use as coarse a gear as this is that we want it to be as strong a gear as we can get into the space which we have (reason No. 34). The spiral gears will wear longer the larger they are, since the pressure between the teeth for a given moment will be less the greater their diameter (reason No. 35). We have comfortable room for a 24-inch gear which, if made with teeth of 1½ inches circular pitch, ought to be enough to carry all that the step gears can transmit without undue wear. This is a guess (reason No. 36).

SIZE OF SHAFTS.

This leads to more guess-work, as the sizes figured to carry the torsional stresses coming from the power transmitted would be so small as to look altogether wrong to a machine toolmaker. If 12 inches is about right for a spindle which does not carry the torsional stress, 4 inches ought not to be too large to carry the torsion on a shaft running 5½ times as fast. What is needed in machine-tool transmission is shafts stiff enough so that no tremble whatever is transmitted back from the work to the driving-gear, and that requires considerably greater sizes than in other work (reason No. 37). For the horizontal shafts 1 11/16 to 1 15/16 inches will look about right, following the same reasoning (reason No. 38). This driving mechanism of Fig. 9 can be placed outside the base either at the back or at the right-hand side of the machine, according to how the purchaser wishes to place it relative to the line shaft. If placed at the side of the machine shaft s which runs all the time at at a constant ratio to the table speed, we have a good place from which to take off the feeds for the heads while, if the drive is at the back, another pair of bevels or spirals is inevitable. The power for raising and lowering the cross rail must be taken from the first driving shaft, since its speed is regulated only by the countershaft, and no other shaft need run while the cross rail is being moved up or down.

The size of driving pulley will be regulated by the size of chip which we expect to take. The results of the Manchester

experiments with high-speed steel seem to indicate that a pressure of about 115 tons per square inch of cross section of chip is a fair basis on which to estimate (reason No. 39). If we intend to run at 50 feet per minute, which actual use seems to warrant (reason No. 40) for heavy work, this means about 350 horse-power per square inch of cross section. Now 50 horse-power will look to my client like a lot of power to have available to drive this one machine, but we will figure on this and let him run as much lighter as he pleases. This, leaving out friction, will allow us a chip of 1/7 of a square inch cross section which, even if divided between two tools, will be a reasonable cut (reason No. 41) as it represents the removal of a trifle over 20 pounds of metal per minute. Our driving shaft, as planned, is to run 250 revolutions per minute. If 3750 feet per minute is assumed as the limiting speed for our belt, and we assume 600 feet of 1-inch double belt per minute to transmit 1 horse-power (reason No. 42) we will have to use a belt 8 inches wide on a 57-inch pulley. Since this pulley "looks" too large (reason No. 43) we will put in another shaft and a pair of gears and speed it up to 500 revolutions, and cut the diameter to 40 inches, which will allow for the other countershaft speed being slower. The pull (effective) on this belt will be about 440 pounds, which gives us a pressure on the teeth of the smallest pinion of 1500 pounds. According to the Lewis formula a cast-iron gear of the assumed pitch and 2½ inches face will just carry the pressure. Since we are going to use steel, we will probably have a sufficient allowance for shock in throwing the gears in under load.

RETROSPECT.

This covers about all the designing on this mill except what more properly belongs to ingenuity, patience and precedent. That is, it covers just about what we expect to be able to get from machine-design books. Now let us see how we can classify the reasons given above. Out of 43 reasons given we have:

Judgment from precedent including rule of thumb	18
Common sense	9
Personal opinion	4
Copying	3
Professor Sweet	3
Convenience	3
Computation or experiment	3

In the above classification "copying" might be put in under the first heading, "judgment from precedent" and those laid at Professor Sweet's door, might be put under the head of "common sense," as also might those under "personal opinion," if it were not for the fact that some critics might disagree as to their value. This classification seems to show that for a designer a large knowledge of what has been done, and a stock of common sense are much more valuable than a knowledge of computation and experiment (as such). But it is of these last two that books on machine design treat almost entirely.

There are several conclusions that can be drawn from this—one that the man in the shop must not be entirely discouraged from expecting to become a designer because he has not the advantage of higher education, another that the young man with a higher education and no comprehensive knowledge of precedents had better keep an eye out for trouble, also that he should learn to regard what has been done successfully as being apt to be along the right line, and as something to be treated with respect till proved ridiculous. Again we conclude that a book treating design from a working point of view would be a good thing, and then we conclude that perhaps these writers of books treat of the only side of the subject that can be conveyed by the printed page. It is almost impossible to put down on paper the actual thoughts which chase through one's mind in designing even the simplest machine, and to the beginner in design the omission of the simplest step in the work will sometimes throw him off the track.

A Reversible Angle Shear.

We illustrate herewith a new shearing machine for angle irons which is so designed as to shear the pieces at any angle and right or left hand, the angle being obtained by adjusting the machine—the stock lying always in the same parallel position.

The general construction of the machine is clearly shown in Fig. 1, from which it will be seen that it is mounted on a base plate, on which it is swiveled to obtain the desired angle of cut. The base-plate is graduated to give the angle directly, the swiveling of the machine being accomplished by the hand wheel at the right.

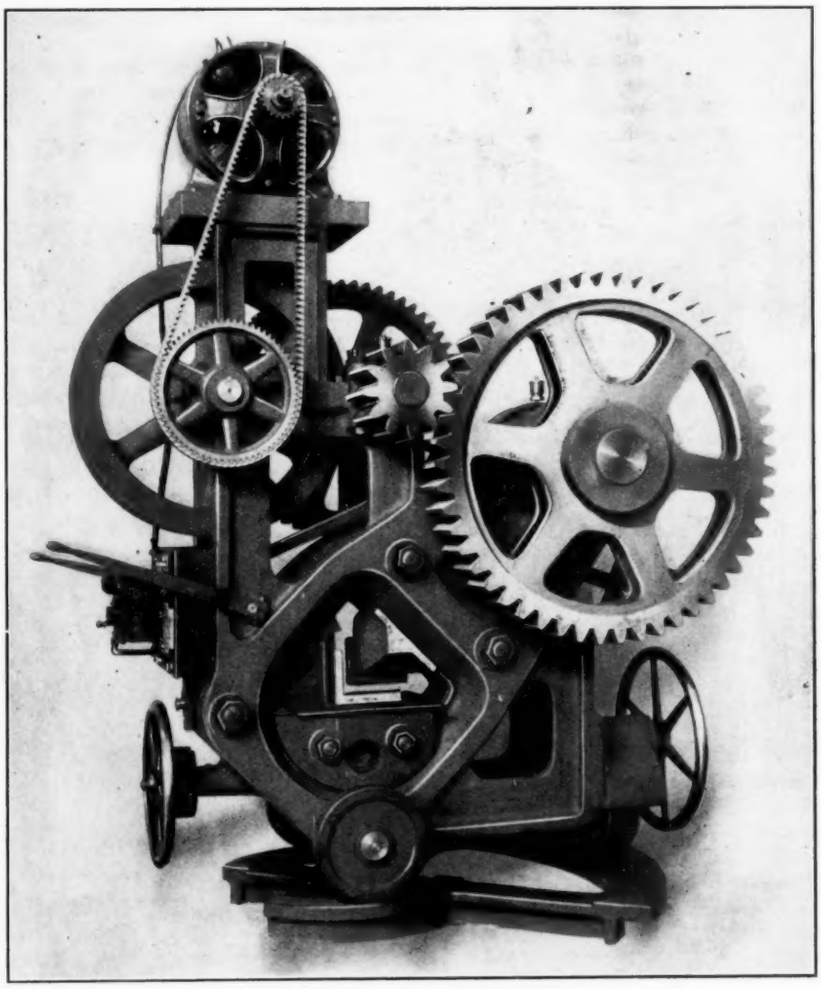


FIG. 1. REVERSIBLE ANGLE SHEAR.

The fundamental novelty of the machine lies in making both edges of the blades cutting edges and in the provision for adjusting the bottom blade for right and left-hand cuts. Fig. 2 shows the adjustment for a right-hand angle cut, Fig. 3 for a square cut and Fig. 4 for a left-hand angle cut. Were the left-hand cut attempted with the machine in the position of Fig. 4, but with the blades adjusted as in Fig. 2, the heels of the blades would engage the work, violently wrenching it to a position for a square cut. To adapt the blades to both angular cuts the lower

blade is fitted in a heavy bolster *a*, Fig. 5, which by the hand wheel shown at the left in Fig. 1 is made to traverse horizontally by a distance equal to the sum of the thickness of the blades, thus bringing the lower blade to the position sketched in Fig. 4. The action is best understood by comparing the presentation of the blades to the work in Figs. 2 and 4, both of which will be seen to be correct. Fig. 5 shows a side view of the blades and a section of the work.

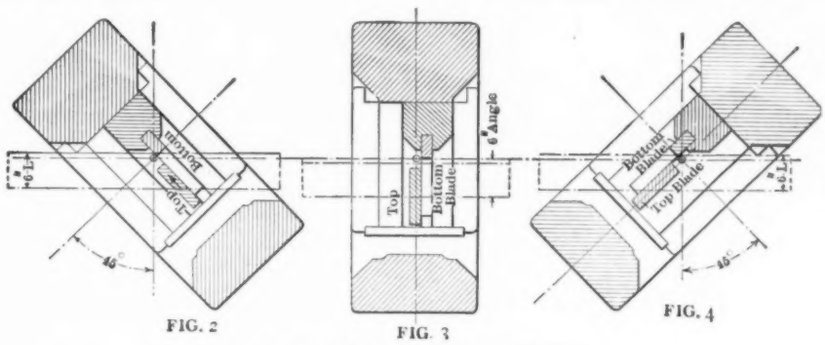


FIG. 2 FIG. 3 FIG. 4

PLAN SECTION IN THREE ADJUSTMENTS.

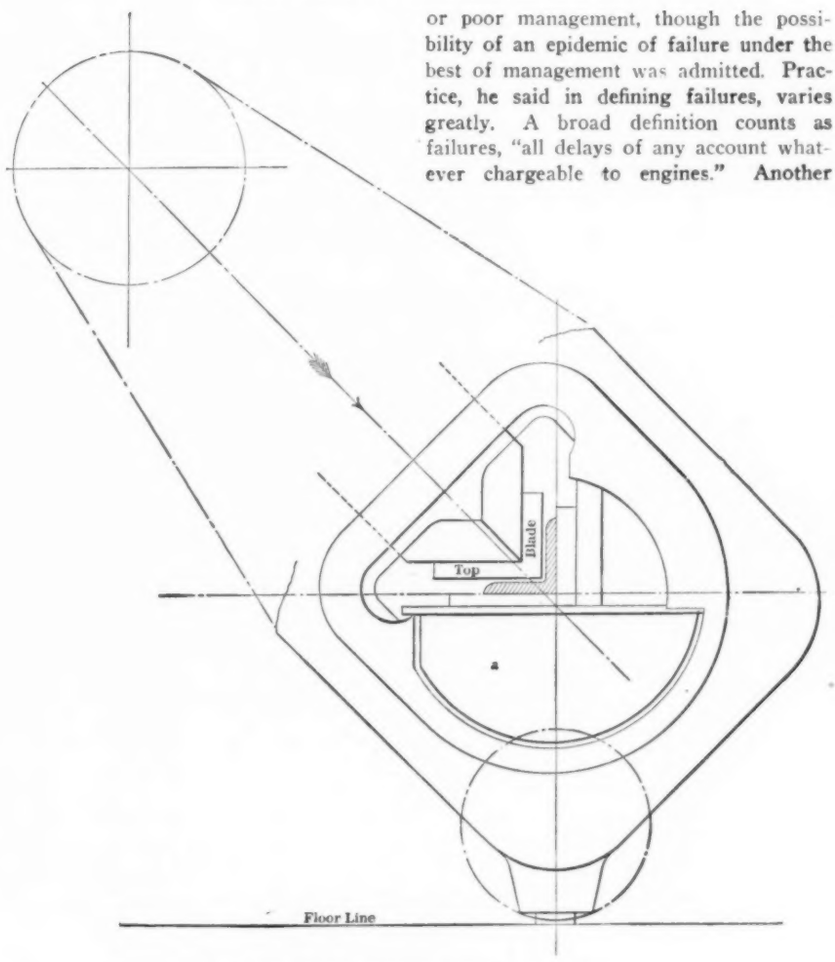


FIG. 5. SIDE VIEW SHOWING ACTION OF BLADES.

The machine, which is a recent product of William Sellers & Co., of Philadelphia, obviously simplifies in large degree the getting out of the numerous braces of structural iron work.

Engine Failures.

M. K. Barnum, assistant to the second vice-president of the C., B. & Q. Railway, addressed the engineering students of Purdue University on January 29. His subject was "Engine Failures." The importance of the subject was emphasized by a statement to the effect that the proportion of engine failures to mileage is to some extent an indication of good or poor management, though the possibility of an epidemic of failure under the best of management was admitted. Practice, he said in defining failures, varies greatly. A broad definition counts as failures, "all delays of any account whatever chargeable to engines." Another and a much narrower one is, "a delay of more than 5 minutes to a passenger train or of more than 10 minutes to a freight train at any one point, due to broken, defective, or lost parts of machinery, hot bearings or leaky boilers." A generally accepted definition which lies between these limits makes a failure "any defect in an engine or its mechanical operation which causes it to lose time or make stops which would otherwise be unnecessary." The speaker discussed the effect of engine failure upon the cost of operation, loss of business and the movement of traffic; he then analyzed the causes leading to such failures and described the manner in which failures are reported and the methods by which the higher officials handle the statistics based thereon. Attention was especially called to the importance of shopping engines at proper intervals, larger engines in freight service requiring to be shopped after running from 45,000 to 60,000 miles while smaller engines in lighter service will frequently run for 75,000 to 125,000 miles between shopping. A careful study of the requirements of different classes of engines with reference to shopping will greatly assist in reducing failures on the road.

In his discussion of details it was shown that technical failures of engines were often failures of men, the apparatus being in satisfactory condition but delays occurring through inattention or faults on the part of the crew. He said also that the reverse condition sometimes existed, that through prompt and wise action on the part of the engineer, a technical failure may be actually avoided. Failure of the first class occurred when an engineer brought his engine back to the roundhouse because of an alleged failure of injectors, whereas in fact the injectors were in working order but were not properly handled. This, he said, while recorded as an engine failure, was really the failure of a man. As an illustration of the manner in which technical failure may sometimes be avoided, a case was cited where an engine within four miles of a terminal broke its piston rod; the cylinder head, piston and rod all being blown clear off the engine. The engineer, knowing that all harm had been done which could be done, held his throttle open and got into the terminal on time, thus avoiding a technical failure; notwithstanding the fact that there was actual and serious breakage of parts. In conclusion, attention was called to the extremely satisfactory records which many roads are now enjoying with reference to engine failures; a good record being regarded as one which permits a mileage of 10,000 miles per failure, while some roads are today operating with less than one failure to 15,000 miles.

Words are for the transmission of thought, just as belts are for the transmission of power; and sometimes they are both poorly laced together.—*The Wood-Worker.*

Tests of High-Speed Tool Steels on Cast Iron.*

BY L. P. BRECKENRIDGE AND HENRY B. DIRKS.

In what follows is a description of experiments made by H. B. Dirks, Assistant in Mechanical Technology, Engineering Experiment Station, in the shops of the College of Engineering at the University of Illinois. These experiments have been in progress for nearly a year, and every effort has been made to obtain useful and correct results.

I. THE TOOL STEELS USED.

(*a*) *The Brands Used*

The following tool steels were used in these trials:

1. Styrian marked "Böhler Rapid"
2. Jessop's "Ark"
3. McInnes's "Extra"
4. Mushet's "Special"†
5. "Air Novo"
6. "Rex"
7. "Poldi"
8. "A and W" (Armstrong and Whitworth)

The first six came from the American market. Poldi and "A and W" were furnished by the American Radiator Company, having been used in its foreign factories. With the exception of the Mushet, the steels used were donated for the proposed tests by the makers or agents. The Mushet was taken from stock purchased in the open market. There are doubtless other kinds of steel which could have been tested, but these eight brands were most familiar and accessible to the writers, and it is believed that they represent fairly well the brands commonly used at the present time by American manufacturers.

(*b*) *Size and Shape of Tools*

The size of the bars of steel from which the tools were made was ½x1 inch for the steels from the American market. The Poldi bar was ¾x1¾ inches, and the "A and W" bar was ¾x1¼ inches The shape of the tool used in the tests is shown in Fig. 1. The front clearance was 12½ degrees, the top rake was 10 degrees and the side rake was also 10 degrees. These angles were carefully maintained throughout the tests, the angles being measured with a bevel protractor after each grinding.

Experiments relating to the proper shape of tools have been made by Prof. J. T. Nicolson, and the writers were guided in selecting proper tool angles by the recommendations of his paper. Professor Nicolson says: "Tools should therefore be ground for maximum endurance in the cutting of gray iron in ordinary shop practice so that their true cutting angles are about 81 degrees, or if they are allowed 6 degrees clearance for working on the level of the lathe centers, they should have an included angle of about 75 degrees.

(*c*) *Tempering and Tempering Apparatus*

Directions for forging and hardening the various steels used were furnished by the manufacturers. It will be seen that most of the steels were to be hardened in an air blast. The "A and W" steel was the only one in which oil was recommended for cooling, and then only after the cutting edge of the tool had been cooled to a cherry-red in the air blast. An air-blast apparatus was designed and constructed for carrying out the instructions relating to the proper preparation of the tools. This is shown in Fig. 2.

The apparatus consists of the 4-inch separating pipe, 3 feet 6 inches long, to which is connected the header of 2-inch pipe about 10 inches long. The dimensions and construction are shown in the figure. The tools to be hardened are inserted in the short lengths of 1½- or 2½-inch pipes which serve to concentrate the air blast on the tools. A rubber hose with a ⅛-inch nozzle in the end is also attached to one opening, so that a strong air blast may be directed on the edge of the tool when first removed from the fire. The tools were heated in an ordinary forge with a clear coke fire. The fire was burned long enough before putting in the tool to drive off any sulphur. Care was also taken to have plenty of coke above and below the tool so that no cold blast should strike the tool while it was being heated.

II. THE GRAY-IRON TEST PIECES.

In order that the results of the tests might be of general application, it was advisable that the gray-iron test pieces be the product of several commercial foundries. Several manufacturers throughout the State agreed to furnish sample test pieces representing the grade of gray iron used in their respective foundries. A standard size of test piece was therefore decided upon, and blueprints and patterns of it sent to the different manufacturers. This standard test piece is shown in Fig. 3. The outer diameter is the maximum the lathe will swing over the carriage. This test piece was made hollow for several reasons. A solid test piece becomes soft toward the center and is more likely to contain blow-holes. Test pieces of small diameter become springy and consequently produce inaccuracies in the results. The high angular velocity necessary with small diameters is also undesirable. The first test piece used in the preliminary trials was 18 inches long. This was found to be short, the tool having to be reset too often. The test pieces do not all conform to the standard test piece, the American Radiator Company having sent test pieces with a 6-inch core

Name of company sending test pieces		Identification mark	Test reference No.	Hardness by drill test
American Radiator Co. Chicago, Ill.	Pierce plant.	3 " core	3	94.2
			4	109.2
			5	102.0
	Michigan plant.		6	128.8
		5-8-05	7	86.5
			8	94.3
		6 " core	9	138.6
			10	106.8
			11	109.3
	Detroit plant.	D. P. 1	12	100.0
		D. P. 2	13	106.6
		D. P. 3	14	117.2
		D. P. 4	15	132.0
		D. P. 5	16	109.8
		D. P. 6	17	90.3
	——— plant.		18	107.0
		5-17-05	19	117.2
			20	113.9
	——— plant.	B	21	124.8
		5-26-05	22	167.5
			23	122.2
	——— plant.	B	24	111.2
		6-2-05	25	102.4
			26	95.9
Crane Company Chicago, Ill.	Ferro Steel.	F. S.	1	342.0
	Gray Iron.		27	132.0
Root & Vandervoort Eng'g Co. East Moline, Ill.			2	175.0
University of Illinois Urbana, Ill.		U. I.—1	28	114.5
		U. I.—2	29	195.0
		U. I.—3	30	124.2
		U. I.—4	31	124.5
		U. I.—5	32	123.2

TABLE 1.

Results of Hardness Tests and Identification Marks of Gray-Iron Test Pieces Used in the Tests.

*From Bulletin No. 2 of the University of Illinois Engineering Experiment station.

†Professor Breckenridge informs us that his attention has been called to the fact that the Mushet Special steel was not the brand of high-speed steel put on the market by agents of the Mushet steel as their high-speed steel, and he adds: "Some confusion arose in the purchase of this steel for our tests. It is doubtless true that we should not have put the Mushet Special brand in with the list of other steels tested." Ed.

instead of a 3-inch core, from several of its plants, that being a more representative casting from its foundries. The test pieces received from the various companies, their identification marks and reference numbers are shown in Table I.

A comparative hardness test was made on all samples, comparison being made with a standard piece of soft gray iron of equal density throughout, the chemical analysis of which is as follows:

Com. Carbon= .147% Silicon =2.35% Sulphur= .07%
Graphite =5.03 % Mang'se= .33% Phos. =1.06%

The hardness of gray iron or any other metal as indicated by a drill test is probably as fair an indication of the particular quality of the metal that affects the cutting speed as is obtainable by any process in use at the present time. This hardness test is in itself a cutting-speed test in which the cutting speed is not varied, but is held constant and the rate of feed allowed to vary, the cutting speed and rate of feed in all probability bearing

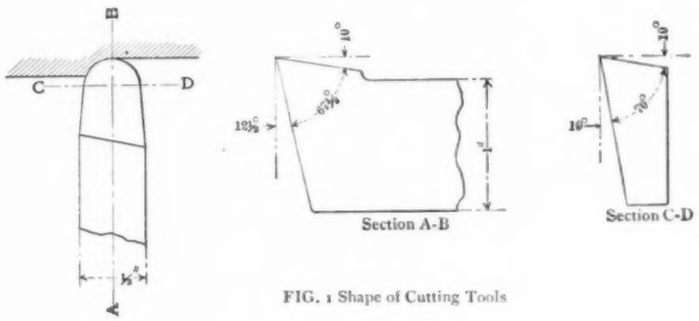


FIG. 1 Shape of Cutting Tools

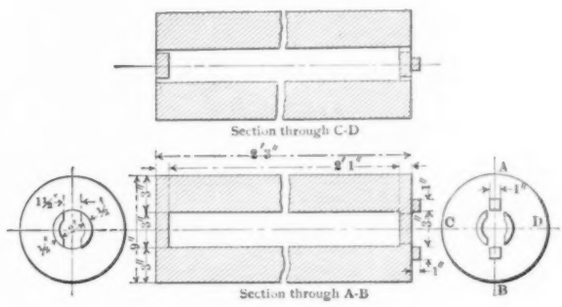


FIG. 3 Standard Test Piece

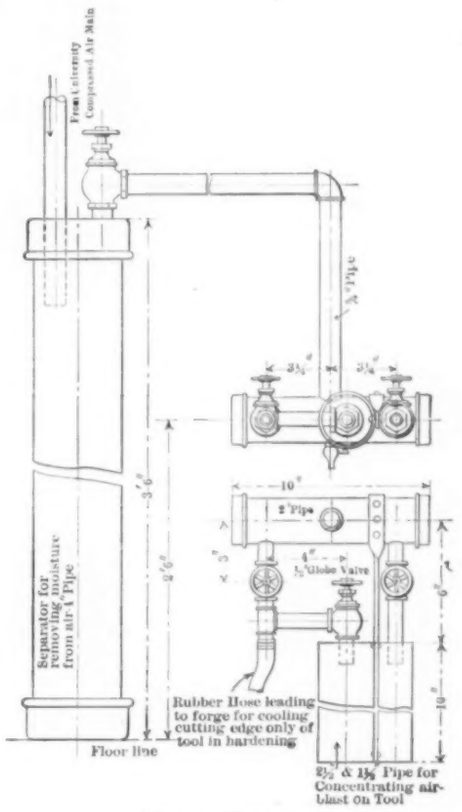

From Liberty Compressed Air Main
Separator for removing moisture from air Pipe
Rubber Hose leading to forge for cooling cutting edge only of tool in hardening
Floor line
2 Pipe
Globe Valve

FIG. 2 Air Blast Apparatus

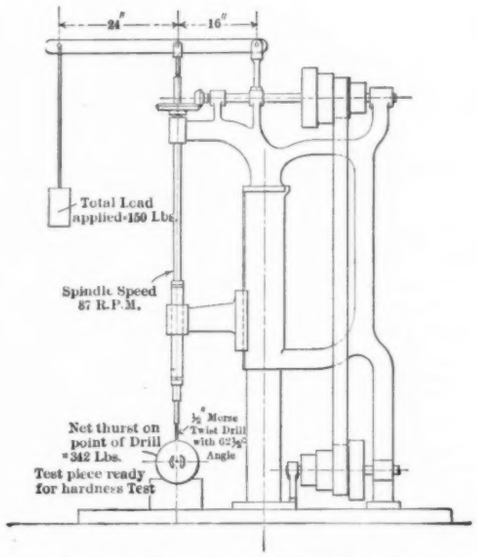

24"
16"
Total Load applied-150 Lbs.
Spindle Speed 87 R.P.M.
Net thrust on point of Drill =342 Lbs.
Test piece ready for hardness Test

FIG. 5 Drill Press, showing Method of making Hardness Tests on Cast-Iron Test Pieces

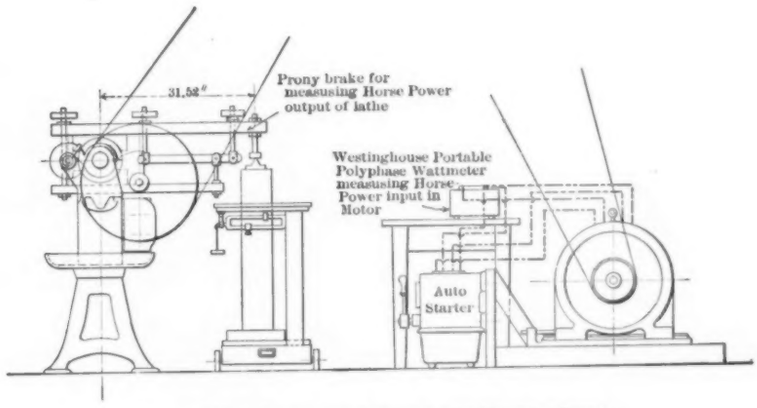

31.52"
Prony brake for measuring Horse Power output of lathe
Westinghouse Portable Polyphase Wattmeter measuring Horse Power input in Motor
Auto Starter

FIG. 6 Arrangement of Apparatus for Measuring Power Absorbed by Friction in the Lathe, Counter-Shaft and Belting

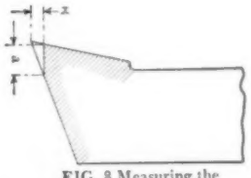


FIG. 8 Measuring the Durability of Tools

TESTS OF HIGH-SPEED STEELS.

some constant relation to each other. Fig. 4 is a graphical chart giving the results of the hardness on the test pieces used in the experiments. The tests were made with a drill press as shown in Fig. 5. A constant load of 312 pounds was applied on the spindle of the drill press by means of the weighted lever. With the spindle rotating at a constant speed of 87 r. p. m., the rate of feed of the drill in inches per minute was measured, readings being taken for every ⅛ inch of depth drilled. The drill used was a Morse standard ½-inch twist drill ground to an angle of 62½ degrees. As, however, there was some liability of variation in the sharpness of the drill, thus affecting its rate of feed, a uniform piece of gray iron was first drilled into, readings taken, and then the test made on the test piece. A comparison was thus always made with this same piece of gray iron, eliminating any small variation in the sharpness of the drill. In Fig. 4 the curves drawn through the dots represent the standard gray iron, and those drawn through the circles represent the test piece. Thus for test piece No. 1 the rate of feed is about .174 inch per minute, while in drilling the standard gray iron, the rate of feed is about .595 inch per minute. The hardness as used later and as expressed in Table 1 is $\frac{.595}{.174} \times 100 = 342$. Assuming 100 as the hardness of the standard gray iron, Table 1 gives the results obtained from these tests. This method of expressing the hardness of gray iron was also used by Prof. J. T. Nicolson in his experiments with high-speed tool steels made at the Manchester Municipal School of Technology, Manchester, England. In these experiments the tangent of the angle made by the curve was used as the hardness.

III. DETAILS OF THE TESTS.

(a) Apparatus

The apparatus used in conducting the tests consisted mainly of a high-speed lathe deriving its power from a two-phase induction motor by means of belting and a countershaft, the power required being measured by a polyphase wattmeter. The lathe used was a Pratt & Whitney high-speed lathe with a gear-box headstock, taking a maximum length of 3 feet 9 inches between centers and a diameter of 9 inches over the carriage.

The power was transmitted to the lathe by means of a 4-inch double belt from the 12-inch friction clutch pulley of the countershaft. The countershaft in turn was driven through a 37-inch pulley by a 4-inch single belt from the motor. The motor is on an adjustable base, allowing changes of the motor pulley to be made without changing the length of the belt. In the tests, pulleys ranging from 6 to 12 inches in diameter were used, making possible with the 8 changes of speed on the lathe proper, 56 changes for every diameter of work. As the diameter of the test piece decreased, it was thus possible to keep the speed of the cut constant within very small limits.

(b) Procedure in Making the Tests

In the preliminary trials the skin was first removed to bring the test piece to a uniform diameter throughout. This was discontinued in the later trials and a separate series of skin-cut trials was run. The test piece having been made ready for the test, the tool to be used was placed in the tool rest in the position decided upon for all tools and trials, viz., at right angles to the work with the bottom edge of the tool horizontal and the cutting edge of the tool from ⅛ to ¼ inch above the center of the work, its exact position be-

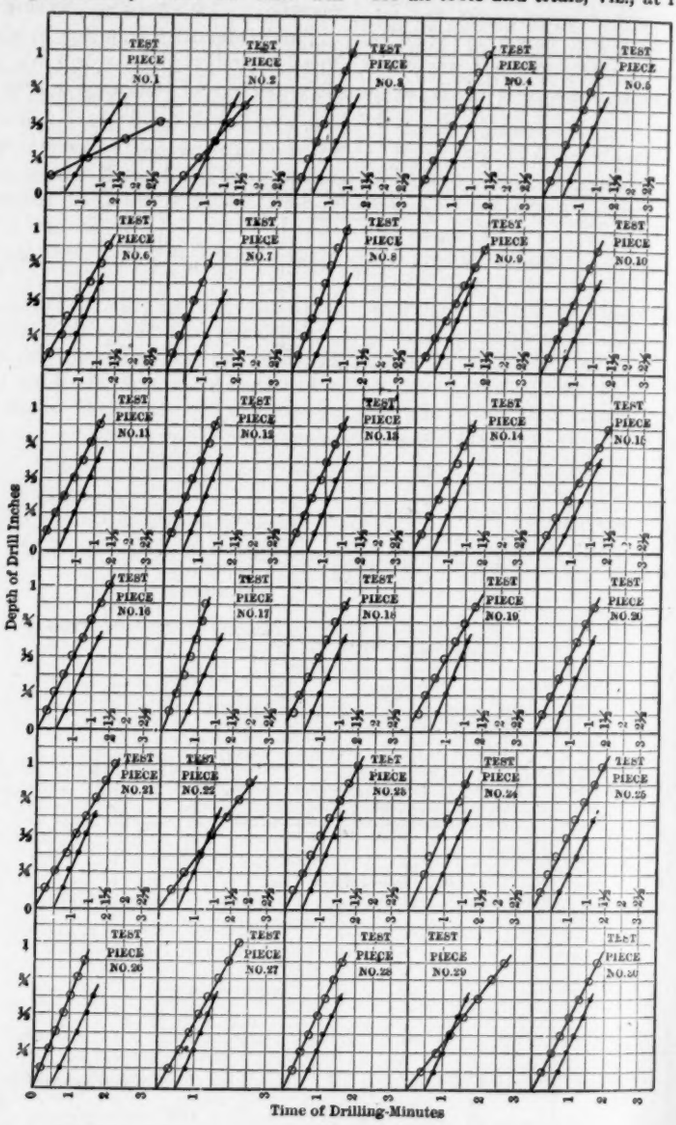


FIG. 4. GRAPHICAL CHART OF HARDNESS TESTS MADE ON TEST PIECES.

Name of Company Sending Test Pieces		Average Hardness of Test Pieces	Allowable Cutting Speed
American Radiator Co. Chicago, Ill.	Pierce Plant	101.8	132.0
	Michigan Plant	110.7	118.0
	Detroit Plant	109.3	120.0
	——— Plant Marked 5-17-05	112.7	90.0
	——— Plant Marked B 5-26-05	138.1	60.0
	——— Plant Marked B 6-2-05	103.1	132.0
Crane Company, Chicago, Ill.	Gray Iron	132.0	63.0
	Ferro-Steel	342.0	28.0
Root, Van Dervoort Eng'g Co. East Moline, Ill.		175.2	48.0
University of Illinois M. E., Dept. Shops.		136.3	60.0

TABLE 2.

ALLOWABLE CUTTING SPEEDS FOR GRADE OF CAST IRON USED IN THE TESTS.

ing recorded in the log. The diameter of the test piece was then accurately measured in several places and the average recorded in the log. The tool was then fed in by hand until the cutting edge just scraped the bottom of the groove left by the last turning. The graduated disk on the cross-feed having been set at zero, with the tool in the above position, the cross-feed was turned back a little, and the carriage moved to the right sufficiently

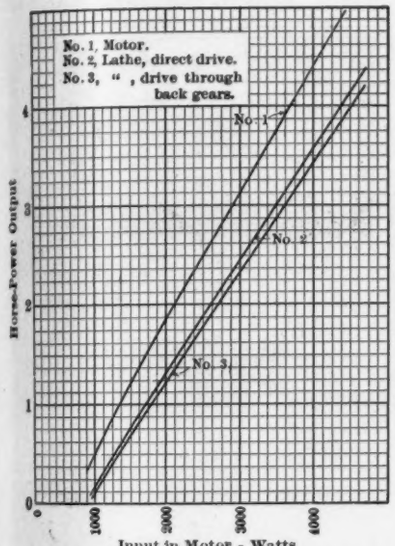


FIG. 7 Curves Giving Results of Experiments to Determine Loss of Power in Lathe and Countershaft for Varying Loads

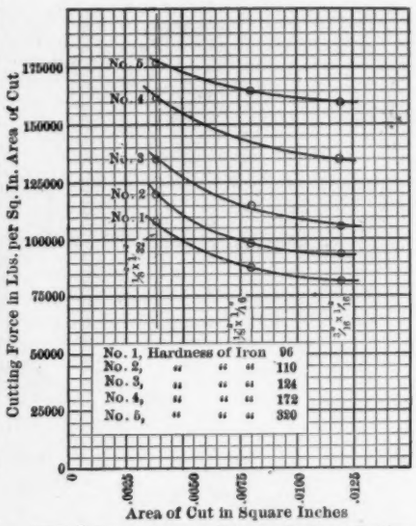


FIG. 9 Curves Showing Relation Between Cutting Force on Point of Tool and Area of Cut for Cast Iron of Varying Hardness

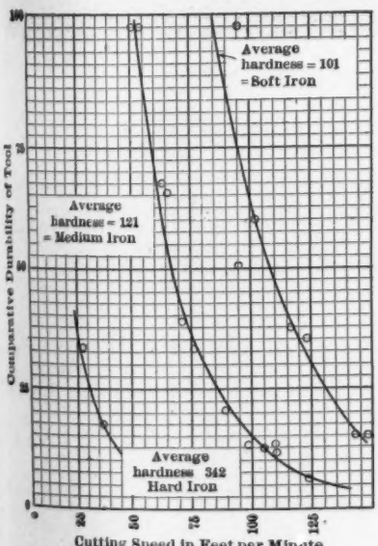

Average hardness = 101 = Soft Iron
Average hardness = 121 = Medium Iron
Average hardness 342 Hard Iron
Comparative Durability of Tool
Cutting Speed in Feet per Minute

FIG. 10 Curves Showing Variation of Durability of Tool with Cutting Speed for Cast Iron of Varying Hardness Average of all Tool Steels

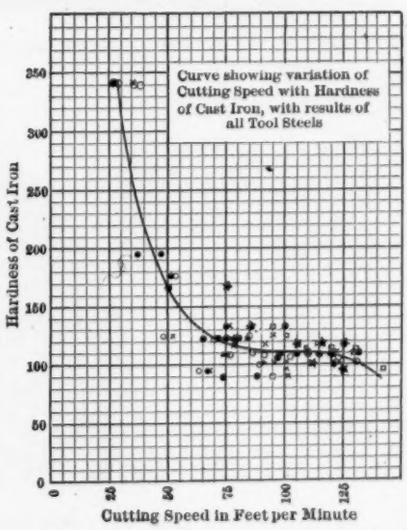

Curve showing variation of Cutting Speed with Hardness of Cast Iron, with results of all Tool Steels
Hardness of Cast Iron
Cutting Speed in Feet per Minute

FIG. 11 Curves Showing Cutting Speeds it is Advisable to use with a Variation in the Hardness of Cast Iron

for the tool to clear the test piece. The cross-feed was then advanced until the graduating disk showed the required cut opposite the index mark. The longitudinal feed or traverse was then set in position and recorded in the log. The diameter of the work and the surface speed required during the trial being known, the size of the pulley to be used on the motor and the position of the driving gear necessary to give the required speed were obtained from a set of curves giving the speed for various diameters of work for each of the 56 changes obtainable. This having been done, the lathe was started and the surface speed tested with a Warner cut-meter. If found to be too far from the required speed, a different combination of motor pulley and cone gear was tried. A satisfactory speed having been obtained, the feed mechanism was started and the lathe allowed to run until the tool had entered the work and was taking the full cut. The lathe was then stopped and the square-case revolution counter, which was actuated by the first motion shaft, set at zero. The lathe was then cleared of all chips and the test started, the exact time of starting and the position of the revolution counter being recorded. During the trials, readings of the revolution counter and also of the wattmeter were taken every two minutes in order to obtain any variations in the cutting speed and the power required. After the expiration of the trial, which occurred either at the time of failure of the tool or at a specified time limit, the tool was withdrawn and the lathe run light under the same conditions of speed as in the trials, in order to observe the electrical horse-power exerted by the motor under these conditions. All cuttings were then collected, weighed and recorded in the log. To faciliate the collection of chips, sheet-iron guards were placed on the bed of the lathe.

(c) Description of Methods Adopted for Measuring the Force Required in Cutting

During the trials readings were taken at regular intervals of the total electrical watts input in the motor while cutting, and after the tool had been withdrawn, with the lathe running light. The difference between the electrical horse-power with the tool cutting and with the lathe running without the cut should give the net horse-power required for cutting, and if this be multiplied by 33,000 and divided by the cutting speed, we obtain the force required for cutting in pounds. In thus figuring, we assume that the lost horse-power of the drive remains constant from no load to full load. To determine whether or not this was the case, a Prony brake was placed on the gray-iron test piece, as shown in Fig. 6. This could be made to offer the resistance otherwise produced by the cutting tool, and this resistance could be measured at the end of the brake arm by observing the reading on the scale beam of the platform scales. The brake arm was made 31.52 inches in length to faciliate the work of obtaining the horse-power, which would then be $\frac{PN}{2000}$, in which P is the net thrust on the scale in pounds and N the number of revolutions of the brake wheel.

Experiments were made on the lathe for both methods of driving it, either direct or through the back gearing. The results of these experiments are given in Fig. 7. In the same figure is also shown the calibration curve for the motor alone, giving the horse-power output for a known input. The loss in the transmission for any known input could be immediately found, it being the vertical distance between the curves at the required load. From the curves it can be seen that it is not constant, but increases at a constant ratio as the load increases. The equations derived from the curves, giving the relation between the net and gross load for both drives, are as follows:

(1) $N = 0.886G - 0.32$ (2) $N = 0.907G - 0.41$

Where N = net horse-power required for cutting, at the tool point, represented in Fig. 7 by the ordinates of the curves No. 2 and No. 3 according as the lathe is running with or without the back gears; and

G = total horse-power output of motor, represented in Fig. 7 by the ordinates of curve No. 1.

In these equations, (1) applies to the

direct drive, and (2) to the drive through the back gears.

IV. RESULTS OF THE EXPERIMENTS.

Some of the most important relations disclosed by the tests are shown graphically on several plates. There were in fact five sets of experiments made which may properly be referred to as:

(*a*) The preliminary trials
(*b*) The skin cut trials
(*c*) The endurance trials
(*d*) Trials to obtain the durability of the steels at different cutting speeds for various sizes of cut, but on gray iron of constant hardness
(*e*) Trials to obtain the durability of the steels on gray iron of varying hardness.

An entirely arbitrary standard of durability was established as follows: A tool whose cutting edge was worn away .002 inch after one hour's use was considered perfect, its durability being expressed as 100. The ratios of the durability of any other tools to the standard will then be the inverse of the ratios of their rates of wear to the rate of wear of the standard. The wear as assumed for the standard is shown in Fig. 8 at x. In the experiments, however, the distance a was measured and x then calculated.

V. SUMMARY OF RESULTS.

(*a*) *Variation of Cutting Force with Area of Cut*

The effort exerted by the tool in cutting was determined as explained in Part III (c). The horse-power lost in driving the lathe and countershaft was deducted from the total horse-power used during the trial, the difference being the net horse-power required for cutting. This was reduced to foot-pounds per minute, and divided by the cutting speed, giving the force exerted. The figures so obtained were reduced to pounds per unit area of cut, and plotted as ordinates upon a base of area of cut in Fig. 9. The curves show that the cutting force was not directly proportional to the area of cut, but decreased as the area increased, and that the average cutting force varied from 50 tons per square inch for soft gray iron to 85 tons per square inch for hard gray iron. Each curve shown in the figure represents a different hardness of gray iron. The relative hardness is shown in the table on the figure.

(*b*) *Variation of Durability of Tool with Cutting Speed*

In Fig. 10 are shown the curves which represent the relation between the durability of the tool and the cutting speed. These are important curves. Each represents a different hardness of gray iron. Referring to the middle curve, which is for gray iron of medium hardness, it will be seen that a cutting speed of 50 feet per minute is satisfactory, the durability being 100. If the speed is increased very materially the durability decreases quite rapidly. It is evident that for each hardness of gray iron, the cutting speed allowable for a maximum durability exists where the vertical line indicating cutting speed is tangent to curves similar to those drawn.

(*c*) *Variation of cutting Speed with the Hardness of Gray Iron*

The curve shown in Fig. 11 represents the advisable cutting speed on gray iron of varying hardness. This curve represents the results of all the tests of the different steels tested. This curve shows: (a) that any of the steels tested can remove very hard gray iron at a rate of 25 feet per minute; (b) that all of the steels tested begin to wear rapidly at speeds a little above 125 feet per minute. Between these two points the relation between a safe cutting speed and the hardness of the gray iron seems to be definitely expressed by the curve. It would seem that gray iron of medium hardness, 100 to 120, could be cut at 125 feet per minute just as readily as at 70 feet per minute, as far as any injury to the tool is concerned. It must be remembered that this curve does not take into account the effect, on the cutting speed, of the variation in the area of cut; the experiments from which the curve was plotted were in all cases those in which the cut was very nearly ⅛-inch depth of cut 1/16-inch feed, so that there is but a slight variation in the area of cut in all of the experiments. From the curve of Fig. 11, we find the cutting speeds given in Table 2 to be applicable to the grades of iron manufactured by the different companies sending test pieces. In order that any company may make use of the curve shown in this figure, it will be necessary simply to determine the average hardness of its gray iron, as explained elsewhere, and where the horizontal line representing this hardness cuts the curve, the possible safe cutting speed may be read on the scale below. This curve should prove useful to various manufacturers.

(*d*) Generally speaking, all the steels tested proved equally effective. It is very evident that there are great possibilities ahead for high-speed steels. Before realizing their full benefit, however, certain

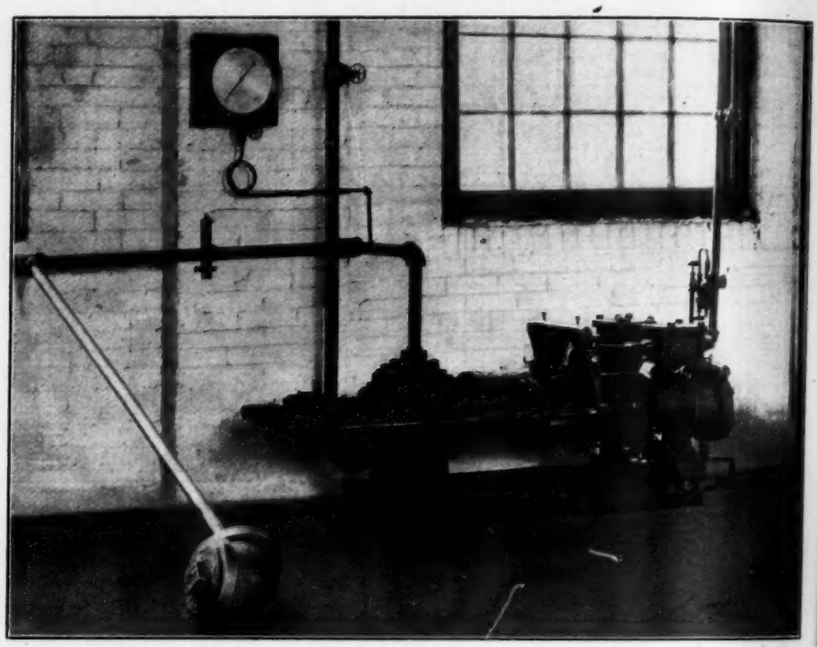


FIG. 1. ARRANGEMENT OF TESTING APPARATUS.

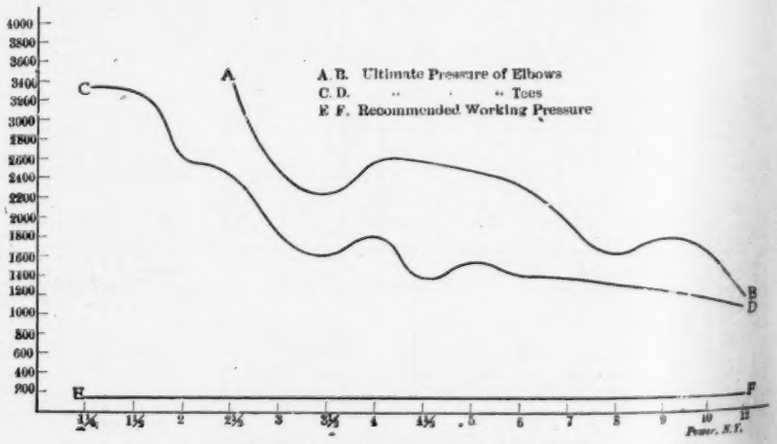


FIG. 2. BURSTING STRENGTH OF CAST-IRON ELBOWS AND TEES.

advances must be made. Heavier machine tools must be built. The capacity of the motors and power plants must be increased. Special hardening furnaces with temperature measuring devices must be available. More must be known concerning the chemical and physical properties of the various steels.

(e) Tools steels are now available that will cut gray iron from two or three times as fast as possible a few years ago. When every advantage has been taken of these possibilities, the cost of manufacturing many articles should be materially reduced.

It is no more a pleasure to the other fellow to hear you brag than it is to you to hear him at it.—*The Wood-Worker.*

The Bursting Strength of Standard Screwed Cast-Iron Elbows and Tees.

BY S. M. CHANDLER.*

It is a generally accepted fact that few, if any, of the accidents caused by the failure of pipe fittings are due only to the pressure of the gas or fluid contained in them, but are the results of combined stresses caused by the expansion and contraction of the pipe, water hammer or pipe improperly supported, any or all of these being in conjunction with a stress due to the pressure of the gas or fluid within the fitting.

*Abstract of Mr. Chandler's Thesis presented to the Case School of Applied Science.

A fitting may, therefore, be subjected to two classes of stresses; one, a legitimate stress, due to the pressure from that which the fitting contains, such as water, steam, compressed air, etc., and the other, due to strains caused by systems of piping improperly designed or installed. Stresses due to the former are tangible and may be estimated with some degree of accuracy, but stresses due to the latter are an unknown quantity varying with the wisdom of the designer and for which the factor of safety must provide.

The dimensions of fittings of different makers vary slightly, so that what is true of certain sizes of one maker's fittings might not be true of another's. The fittings upon which the series of experiments forming the basis of this thesis were made

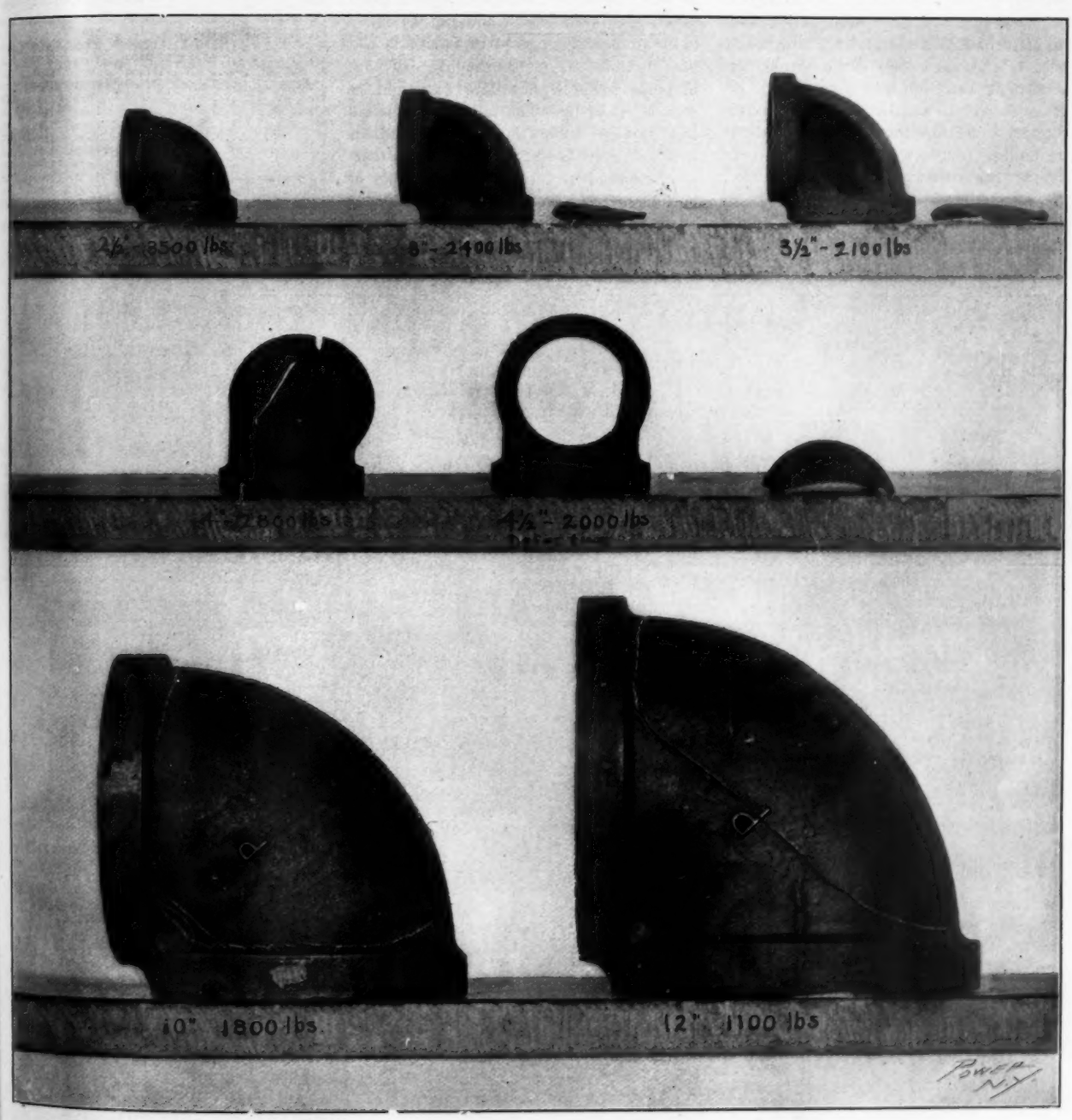


FIG. 3. BROKEN ELBOWS—THE SIZE AND BURSTING PRESSURE OF EACH INDICATED.

were those of the Pittsburg Valve & Fittings Company.

In order that a fair average of the bursting strength of these fittings be obtained, three of each size were taken at random from a stock of pipe fittings, and the bursting pressures of the three averaged for a basis from which to determine the factor of safety. It was also thought advisable to cast a number of fittings of different sizes with one wall of the body thinner than in the standard, and to determine to what extent such a fitting was weakened and the factor of safety decreased. This was accomplished in the foundry by raising the core slightly, thereby adding to the thickness of the metal in the drag side by the amount taken away from the metal in the cope.

The result of all the tests made is shown in the accompanying table, and the strength of the weaker fittings, just mentioned, is shown in smaller type.

All fittings were tested by applying water from a high-pressure steam pump and measuring the pressure on a calibrated hydrostatic gage, the arrangement being shown in Fig. 1.

One or two incidents which came to light during the tests may be of interest. It was found, for instance, that a joint made up of red lead could not be made tight at the high pressures unless it had had a chance to get thoroughly dry; but that one made with tallow was tight as soon as made up. The tallow was melted and applied while fluid to the threads with a brush. On account of the flat surface exposed to pressure in a plug or bushing, it was found necessary in nearly all tests to use solid plugs and reinforced bushings in order to prevent their failure

Size.	Elbows			Average.
2½	3500	3200	3400	3400
3	2400	2600	2100	2366
3½	2100	1700	2400	2066
4	2800	2500	2500	2600
4½	2000	2600	2600	2400
5	2600	2500	2500	2533
6	2600	2200	2300	2367
7	1800	2100	1900	1933
8	1700	1600	1700	1667
9	1800	1800	1900	1833
10	1800	1700	1600	1700
12	1100	1200	900	1133

Size.	Tees			Average.
1¼	3400	3300	3300	3333
1½	3400	3200	2800	3133
2	2500	2800	2500	2600
2½	2400	2100	2500	2333
3	1400	1900	1800	1700
3½	1200	1500	1800	1500
4	1800	2100	1700	1867
4½	1100	1400	1400	1300
5	1700	1300	1500	1500
6	1400	1500	1100	1333
7	1400	1400	1500	1433
8	1200	1400	1300	1300
9	1300	1400	1200	1300
10	1100	1300	1200	1200
12	1100	1000	1100	1067

STANDARD SCREWED GRAY-IRON ELBOWS AND TEES—ULTIMATE TEST PRESSURES.

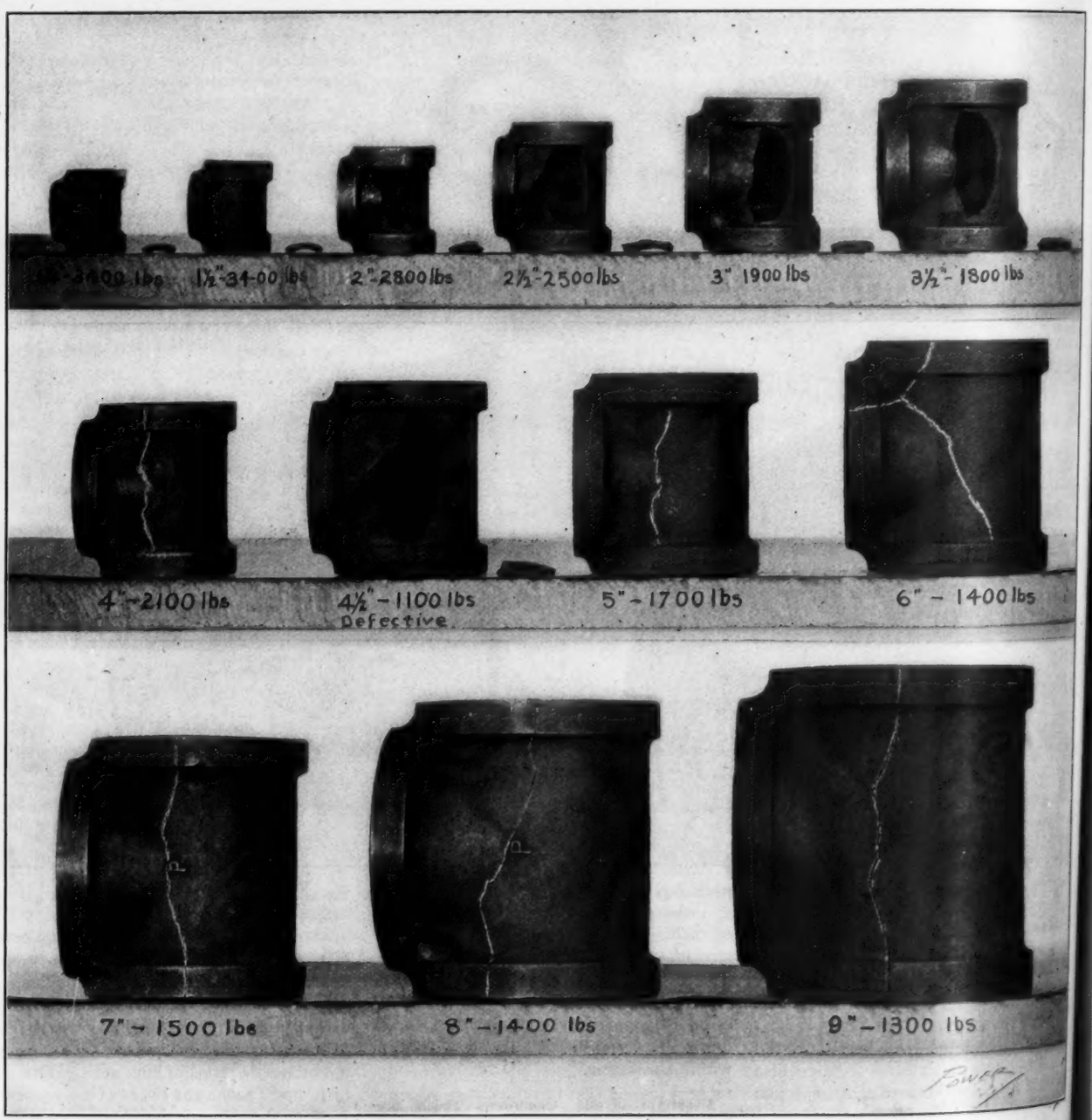


FIG. 4. SEVERAL SIZES OF BROKEN TEES AND THE BURSTING PRESSURE OF EACH.

before the bursting of the fitting to be tested.

In Fig. 2 are shown two curves which represent graphically the bursting pressures attained by the elbows and tees, the curve *A B* representing the elbows and *C D* the tees, the different sizes being arbitrarily denoted on the horizontal scale, with the pressures represented vertically. The line of working pressure recommended by the manufacturer is shown below at 150 pounds and is taken as a basis for calculating the factor of safety.

It is seen that the elbows show a greater strength for all sizes than the tees, and reference to the photographs, Fig. 3, will show that failure of the tees occurred in a majority of cases by breaking a piece from the body of the tee on one side where the metal has a nearly flat surface. This flat surface is entirely avoided in the design of the elbow and undoubtedly adds greatly to their strength. The fact that a tee has a larger inside diameter, measured through the run and the outlet, than the corresponding size elbow, also partially accounts for the higher pressure required to burst an elbow.

The appearance of some of these fittings after fracture and the manner in which they burst may be seen in the reproduced photographs in Figs. 3 and 4. The size and bursting pressure are given under each fitting.

The smaller elbow in Fig. 3 is one of 2½ inches, which did not burst at 3,500 pounds pressure, the highest available with the apparatus. The size and pressure at which the various fittings failed as marked on each photograph and the methods of fracture as exhibited in the illustrations, furnish an interesting study.

Automobile Construction—VII.

BY F. C. MASON.

There are four ignition systems that are very popular and each system has its advocates. They are the multiplex coil using one coil for each cylinder; the single coil and secondary distributor; the make-and-break, and the high-tension magneto. In Fig. 19, I illustrate the wiring of a duplex coil using batteries on one side and a low-tension magneto on the other. The switch on the coil will cut in either batteries or magneto or cut out both; and for all around use, under all conditions, I think this combination one of the most satisfactory. If you desire, you can replace the magneto with another set of batteries.

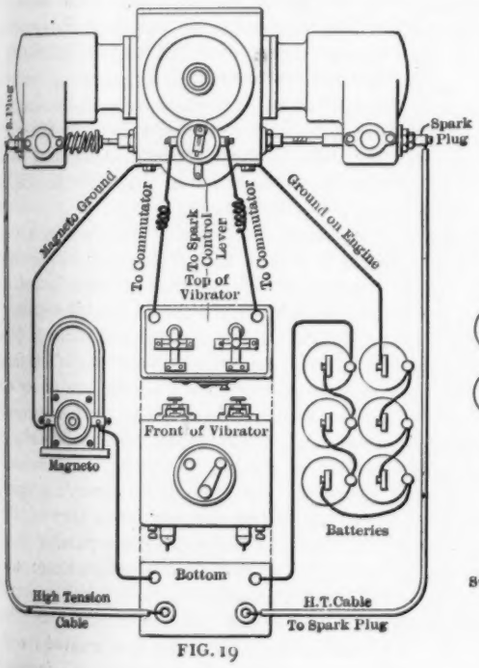


FIG. 19

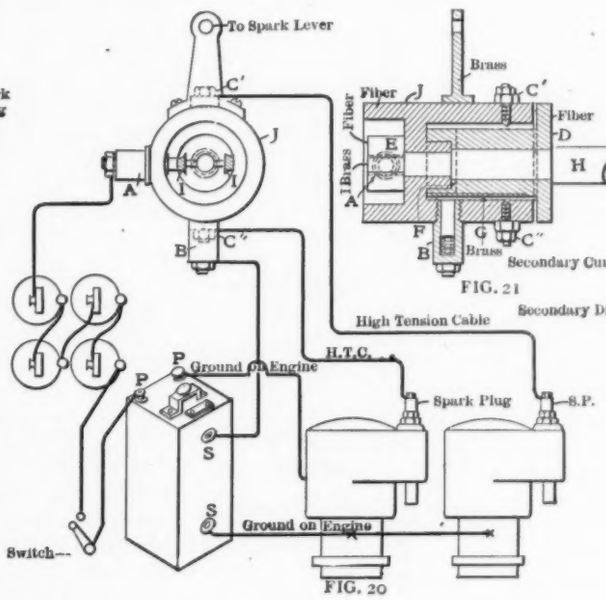


FIG. 20

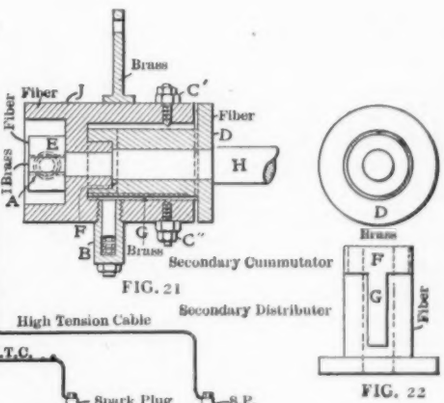


FIG. 21

FIG. 22

IGNITION SYSTEMS.

In using this combination you start with the batteries and then throw out on to the magneto. By this method, the life of the batteries is increased.

Fig. 20 illustrates the secondary distribution method. This method is much cheaper and has many admirers. Here you use only one spark coil for any number of cylinders. The timing is done on the primary circuit commutator and the secondary distribution is accomplished by the secondary commutator. This commutator is a double one illustrated (in section) Fig. 21. This is merely a diagram to show the principle, and is not drawn to scale or worked out just as it should be.

J is the outside shell or case made of fiber or hard rubber and carrying brush holder *A* for the primary winding in the spark coil, brush holder *B* for the secondary winding on the coil, and contact points or brushes *C' C''* which go to the spark plugs. *H* is the cam-shaft of the engine, which carries the two commutators *E* and *D*. *E* is the primary and *D* the secondary or distributor. *E* is a piece of round fiber having two brass contact plates inserted, which are grounded to the shaft.

D is shown in detail in Fig. 22. The body is made of fiber and has a complete band of brass on one end to make a continuous contact with brush *B*. The strip *G* is the commutator bar which makes and breaks the circuit with the contact points, *C' C''*. As *G* and *B* are the connectors to the secondary wires from the spark coil they must be far enough apart so that the current will not arc across.

Brushes *C' C''* and strips *G* do not touch each other by 1-16 of an inch, and the screws *C'*, *C''* are usually platinum pointed. You can also use a magneto in connection with this system as an adjustment to the batteries if desired.

The make-and-break is one of the older systems and is still largely used. In this system you do not use a spark plug but have a mechanical circuit breaker inside the cylinder, operated from the cam-shaft in a 4-cycle engine; and directly, from the crankshaft in a 2-cycle engine. Instead of the high tension vibrator coil, a non vibrator coil is used with a single winding; for current to supply the circuit you can use batteries and magneto the same as in the other cases.

The high-tension magneto is a complete plant in itself. It must be driven by gearing at the same speed as the engine. As I am not fully conversant with the mechanism, I will not attempt to describe it graphically. It is so constructed that it commutates the current automatically and I think that there are a

number made that will start the engine without the auxiliary batteries and spark coil. The original cost is against their more universal use.

The ignition system is most important for if it is not good the engine will not run. The great mistake which is common to car builders as well as amateurs, is to put in something cheap which will answer the purpose. By all means buy a good coil, plugs, and first-class cable to run to the plugs. One of the greatest causes of a poor spark is poor batteries. The average person will go into the supply store and call for a 4 to 6-cell battery. He may ask for the best and because they are new, he thinks they must be O. K. He will then try them out, find the engine does not run any better than before, and he is then at a loss for the reason. When you buy batteries insist upon having them tested with an ammeter; if they do not show 20 to 22 amperes on short circuit, don't take them. If you buy 4 to 6 cells and some run high and others low, the low ones neutralize the others at once, and then they are all bad. If the coil, batteries and plugs are good and the commutator works right you are bound to have a good spark. One of the prime causes for non-combustion is feeding too much oil to the cylinders. If you feed too much oil, it carbonizes and soots the plug; consequently no spark. If you feed the proper amount of oil and the gasolene mixture is right, there will be perfect combustion and the plugs will stay clean indefinitely. There is usually not enough attention given to these two points and they are most important.

Pickling steel has been reported by a number of investigators to have a very bad effect on its quality, making it brittle, and this has been frequently stated of electro-plating effects on the metal. It has generally been held that this deterioration was due to the action of hydrogen in its nascent state, although some have held that the brittleness was due to the penetration of the acid into the mass of the steel. Prof. Charles F. Burgess of the University of Wisconsin has been investigating the phenomenon and his experiments, described in "Electrochemical and Metallurgical Industry," prove that the brittleness of pickled iron and steel is due to the action of nascent hydrogen rather than acid, and is a very serious matter where the metal objects are small.—*Engineering Record.*

The point at which electric traction on the Pennsylvania Railroad's New York terminal system will commence is to be Harrison, N. J., on the eastern outskirts of Newark. This location east of the Passaic river avoids having to provide electrical conductors over a draw-bridge It is stated that large yards will be laid out at Harrison.

The Importance of an Apprenticeship System.*

BY L. D. BURLINGAME.

It is gratifying to see the growing interest in the apprenticeship question among our machinery manufacturers—an interest that is bearing fruit in the adoption of systems of apprenticeship where none have before existed, and in modifications of those already existing to meet modern requirements.

This movement is especially gratifying to me as I stand here to speak of the system in use by the Brown & Sharpe Manufacturing Company, as it indorses the policy consistently advocated and followed by our company for over half a century.

The late Lucien Sharpe was himself an apprentice to Joseph R. Brown in the early history of the business which has had the benefit not only of his rare qualifications for building up the business, but of those of hundreds of apprentices following him, many of whom have advanced to responsible positions in the works, and have made the name of the Brown & Sharpe Manufacturing Company what it is today.

Many apprentices leaving us for other positions have proved themselves loyal missionaries for the extension of the business, in many cases being directly responsible for the placing of orders for our machinery.

With our company the apprenticeship system is not merely a detail incident to the conducting of the business, but one of the very corner stones on which its prosperity and permanence rest. Mr. Sharpe was always strong in his advocacy of the apprenticeship system, and near the end of his life he expressed himself as follows regarding it:

"From the ranks of our apprentices have been selected from time to time those who have taken the most important parts in the management of our shop. In fact, we do not know how we could get along without the help of our boys. They have learned our method of doing work, and are especially interested in the welfare of the business as well. While technical schools and manual training schools are of great importance, it seems to us that nothing can take the place of a boy's being indentured to some first-class concern that will take an interest in him and see that he faithfully fulfils a well-defined term of agreement to which he shall pledge himself. There is no system in vogue and none that has been suggested that would take the place, in our works at least, of the apprenticeship system."

This was in reply to an inquiry made by the editor of the AMERICAN MACHINIST in 1896, when an investigation was made as to the status of apprenticeship in this country. A similar investigation was made later by E. H. Parks, and the results published in *Cassier's Magazine* in 1902. These investigations included reports from several hundred machine-tool, engine and electrical-machinery builders in this country, and showed a majority taking apprentices, about 50 per cent. of whom were regularly indentured by a written agreement. In connection with the investigations, leading manufacturers expressed themselves as strongly in favor of and dependent on such a system.

In 1903 and 1904 *The Engineering Magazine* published a series of articles aiming to increase the interest in the training of apprentices by showing the practical working of the apprenticeship system in a number of our leading shops. It was my privilege at that time to contribute the article on our B. & S. system, going more into detail than will be possible in a paper of this character, although I will quote somewhat from it, as well as from the paper presented here in Worcester before the National Machine Tool Builders' Association by W. A. Viall, on the same subject.

Quoting from Mr. Viall's paper is the best I can do to lighten your disappointment in not having him personally before you tonight to present this subject.

"If our beloved President," says Mr. Viall, "is impressed with the fact that certain classes of our people are guilty of race suicide, what would be his opinion regarding the machine-tool builders? It seems as though but little, comparatively speaking, has been done toward preparing and fitting for our shops men to take the place of those who are passing from us. All larger manufacturers are undoubtedly constantly beset with requests to recommend men for some of the smaller shops, and men are wanted for all positions, including managers, foremen and operators of special machines.

"I appreciate the fact that the tendency of today is very largely to specialize among machinists, as well as among professional men, and there may be a feeling among some that there is not the demand for the all-round man that there has been. But I believe there is today a demand and an absolute necessity for a large number of these thoroughly trained men—men from whom we can select our foremen and heads of departments."

Mr. Viall continues:

"As to age, we find the limit 16 to 18 to be a period that admits of the boys finishing their course before they have become too far advanced in age and consequently less amenable to instruction and discipline. That they must be physically sound goes without saying, for it is purposeless to train up young men who are not going to be able-bodied, as the time given them is entirely lost.

"We have been obliged to pay some at-

*An address before the Worcester Metal Trades Association.

tention to education. I well know that it is not necessary for a good machinist to be able to know when Washington crossed the Delaware or when the Louisiana purchase was consummated; but if we are to bring up a class of young men who are to be true representatives and men from whom we can draw our foremen and managers, they must have some idea of learning and a love for study. We have required the equivalent of our grammar school course. It is not so much what a boy knows that we are looking to as it is to what he has been trained, which makes him a much more apt pupil in the shop.

"Very often we are approached by young men who think they want to learn a trade, and their parents wish to have them, who would be utterly unfit for such work and really have no idea what it means. To indent such a person would be unjust to all parties, and we, therefore, have provided a term of trial, consisting of 480 hours. If, during this time, we consider that we want the young man and he wishes to stay with us, the papers are then signed and these 480 hours are reckoned in with the first year's time. The apprentice must complete 295 days of actual work in a given year before he can start upon the year following, and his pay is regulated strictly according to this record. The company reserves the right to make such adjustment in the apprentice's time as it may see fit by reason of a difference in running time, as, for example, short time or unforeseen breaks.

"As to the prices paid, 6, 8, 10 and 14 cents per hour for the respective years, I would say that, in addition to this from time to time, the apprentices are allowed to have piece work to help them to make whatever they can over and above their regular pay.

"The work is divided practically as follows:

	Weeks
First year—	
Lathe work	50
Second year—	
Drilling	6
Milling	12
Assembling	26
Erecting	6
Third year—	
Erecting	20
Screw Cutting	10
General work	35
Fourth year—	
General work	35
Scraping	3
Planing	12
Total	200

"It is necessary to consider the work that is done, as in any educational system. It is not possible to turn out men who are finished products in any one line, but it does give the apprentices an idea of the general run of work, so that they are able to take hold and specialize later should conditions require it.

"One element that I believe is quite essential is that some one person should have charge of the apprentices. Under the old system every boy was taught to do a piece of work as the one for whom he was working saw fit to teach him. As to the grinding of tools, the drilling of centers and like work, there would be as many different ways of doing it as there were men who had the apprentices in charge. And apprentices are often neglected because the foreman or some other person is too busy to attend to them. Given an instructor of apprentices, however, it is his duty to see that all are instructed in the same manner to do a given piece of work; that time is taken for it, and that it is done properly. Then the general line of work is carried out under the supervision of the various foremen. The instructor of apprentices is also able to look out for those who are away from home. When they are sick or when they need attention outside of working hours, he is at liberty to follow them up and act for the company on behalf of the parents or guardians of the boys. When the number of apprentices is small, it is not feasible to have one man devote his time to this work; but I believe that a man could be selected a part of whose duties would be the care of the apprentices."

The boys are encouraged to attend evening school, especially to study drafting and mathematics; more than a third of them are now pursuing such studies in a systematic manner.

There is a free library for the use of the shop, containing, besides books of general literature, many valuable works on mechanical subjects.

"A Hand-book for Apprenticed Machinists," written by Oscar J. Beale and published by the company, is put in the hands of each apprentice. It contains valuable information of a practical nature that can be better learned from a book than from other forms of instruction.

When a boy begins work he is loaned a set of tools. If he is accepted at the end of the term of trial, these tools are sold to him and his name stamped on each.

In the drafting room there is a form of apprenticeship adapted to the special needs of that department. Here the time of service is two and one-half years, six months of which is spent in the machine shop. The apprentice first enters the drafting room, and, after working there for five months, is transferred to the shop, where he is instructed in the work of the different departments. It is not expected to turn out machinists in this short time. The intention is to familiarize these men somewhat with shop methods, with the use of tools and with the operation of machines, so that they may have a better appreciation of the work they will be called upon to do when they return to the drafting department.

Boys, before being accepted as apprentices in the drafting department, must have had sufficient technical or other preliminary training to have already mastered the rudiments of drafting.

When the boy has already served a full apprenticeship in the machine shop before entering the drafting room, the time is shortened and he is not required to serve further in the shop.

The usual age for entering the drafting department is from 19 to 22 years, and the pay from 10 cents per hour at the start to 17 cents during the latter part of the time. The sum of $50 is paid at the close of the apprenticeship, if merited, as a reward for faithful service.

Another recent development of the system to meet new conditions is the taking of apprentices into the core-making department of our foundry. It was found that experienced workmen for this department were not available. To insure a supply, it was decided to take apprentices to learn the core maker's trade in a thorough maner. The ordinary form of apprenticeship did not seem adapted to such work.

It was thought desirable to have apprentices start at a more advanced age, from 18 to 22 years, so the time of service was made three years only.

As this trade does not give as great an opportunity for future advancement, not holding out as great inducements to enter it, the wages were made higher than for the regular apprenticeship as machinist, commencing at 12 cents per hour and reaching 18 cents.

The payment of $40 required at the commencement for the privilege of learning the trade can be paid in weekly instalments of $1 each, if desired. A bonus of $140 is paid at the end for faithful service.

The apprentices in the pattern shop are given an experience of several months in the foundry and core room during the second year of their service.

The technical and trade schools are often held up as substitutes for a service of apprenticeship. This school question is so intimately associated with that of apprenticeship that any consideration of the latter subject is not complete without touching upon it.

While there is much that is hopeful in the modern development of our school systems and in the proposed plans for their further extension along practical lines, it does not seem that such plans can give the equivalent in training of a service of apprenticeship such as has just been described, especially in cases where the apprentice adds to his experience in the shop the school knowledge he gets by evening study. The boy coming from the school shop, no matter how good his training, must start as an unknown quantity with his new employer and win his way from the beginning.

The boy already four years in the service of an employer as apprentice may have won his confidence and esteem; he may have developed such ability and shown such a spirit of loyalty as to have put himself in the line of promotion even before

he completes his apprenticeship. There is no better way to maintain the vitality and keep up the standard of a shop than by training young men in the shop itself, preparing them to assume the responsibilities later on.

The AMERICAN MACHINIST has said editorially that it is its belief that "the trade of a machinist and the other trades concerned in the building of machinery can not be properly taught except by a good and thorough system of apprenticeship; that if there is to continue to be a supply of good and competent workmen, they must be trained in a systematic manner after careful selection."

Among the plans that have been suggested as a substitute for a service of apprenticeship, one of the latest proposed is the compromise of a "half school and half shop," advocated for some years by Milton P. Higgins, of Worcester, Mass. This has been taken up by Herman Schneider, in an address before the Cincinnati Society of Mechanical Engineers. The editor of the AMERICAN MACHINIST devoted a leading editorial to a discussion of the plan, speaking enthusiastically of it and predicting its success. Such a plan would, however, give a boy only half the years of experience in shop work that he would have if continuously working in the shop. The fifth year of apprenticeship in the plan proposed might be taken at the beginning in additional school work and then, during the four years' apprenticeship in the shop, evening study could be continued at a good school within reach. This would give a more thorough training in shop work and sufficient advancement in school work to make a foundation to build on, if the boy had it in him to advance. This is certainly the simpler solution from the manufacturer's standpoint. We find that even four years devoted entirely to shop work is none too much, and can only give a general experience in the machinist's trade.

I would not put any obstacle in the path of the schools, but any development in that direction should not close our eyes to the needs of training young men in our own works by a system of apprenticeship binding them by a definite written agreement as to time of service and wages, with a money forfeiture in case of failure on the part of the apprentice to fulfil his agreement, and with a reward at the end for faithful service.

And I would specially emphasize the importance of its being someone's duty to keep in touch with the boys throughout their service of apprenticeship, taking a personal interest in them and seeing that they make the most of themselves, both in their own interests and in the interests of their employers.

Despair never yet got a man an increase in wages, nor lightened the burden of his work.—*The Wood-Worker.*

Letters to the Editor.

Some Experience in Drawing Tin Cans.

At one time I took a position with a firm engaged in exploiting a process for the manufacture of seamless tin cans.

Two young men with plenty of money and a taste for experimenting, aided by a lawyer without mechanical knowledge, were induced to invest in an Italian patent for a process of making deep drawn metal ware. What they paid for this patent I do not know, and I hope not much, but I do know that at least the lawyer had a pleasant trip to Italy to look up the matter.

A U. S. Patent was afterwards applied for, and resulted in one claim which was a wonder. It was a patent, and reflected great credit on the lawyer for getting anything, for judging from the multitude of references cited against it, people in the United States had been thinking before the Italian was born.

The first move after the lawyer had made a satisfactory report concerning the condition of business in Italy, was in the nature of experimental work at the factory of a well known press manufacturing company, whose mechanical engineer was engaged as consulting engineer. The object aimed at was the production of a can, of the tomato can variety, in two parts, the body proper and the cap; the body, instead of having the bottom and sides soldered together, as is the usual practice, to be drawn up out of one piece of sheet metal, in two or three operations.

At that time, and to-day, the limit of drawing up anything of this kind commercially, was reached in a height of about two-thirds of the diameter. The tomato can is of about one and one-third diameters.

The line of samples brought from Italy showed proportions equal to this, and the lawyer saw some made while he was there. He did not, however, know how many were made in getting one good one—that was developed at a later trip made by myself.

Experimenting to obtain this result, was carried on for about two months, at the aforesaid factory, under the direction of the engineer, and aided (?) by an expert (?) sent over from Italy. As this expert could speak no English, and was not familiar with our tools, there was some question as to his value as a business proposition, to the company. At any rate, at the end of two months, the results obtained were not astonishing. We had a few samples and at one time were able to run a press continuously for several minutes without a break. It was then decided to forego the services of the expert, and he was sent back home, and I went with him to see how they were progressing over there.

Like the lawyer I had a pleasant trip to Italy, but unfortunately the factory, which was located at Bologna, was no longer making deep drawn tinware, but turning out tin cans in the same old way. Every courtesy was however shown me and two measly little presses on which the samples were made were again started up, and we obtained some more samples, using both American and Italian sheet metal. But the fault was evidently not in the sheet metal, as the Italian broke as frequently as ours.

This factory in which were employed at that time possibly 30 or 35 men and women, had a manager, mechanical engineer, assistant engineer, one or two draftsmen, and I do not know how many other officials whom I did not see. They were all of the theoretical type however, and I do not think one ever did or could run any machine tool. I lost caste considerably by soiling my hands in attempting to get a more intimate knowledge of some of their tools.

The net result of this trip was also a minus quantity, except as to knowledge of what not to do.

During my absence the experimenting had been going merrily on and it had been decided to start a factory. I have often wondered about this decision, as there were certainly no results on which to base any very elaborate expectations though there were prospects, and there was a nice order for presses to be placed if the project was to be carried on. I believe the consulting engineer's position at that time must have been a rather trying one. However, aside from joking, there were two young men with plenty of money, money which would have gone into steam yachts if not into machine tools, and moreover, if the project should be successful it would give employment to a large number, and if not, the experimenting would add to our knowledge of metal working, and I haven't the slightest doubt but that these young men knew that their chances of success were not of the best.

Anyway, a factory was engaged and equipped in a small way with a very up-to-date plant; seven powerful presses with individual electric drives, other smaller presses, sheet metal working machines and a complete little die-making outfit being installed, and in fact nothing was omitted which could add to the success of the undertaking, the establishment even including a directors' room with expensive furniture, double curtains and shower baths.

The method adopted for definite trial was to draw up the bodies of the cans in three operations and presses were especially designed for each operation and connected by link belting and chutes, so that as a partially formed body was punched out from the first operation press it was carried to the second and thence to the third. At the first operation a blank

of about 11 inches diameter was cut out and drawn up to perhaps two-thirds of its diameter. The second operation made its height a little greater than its diameter, and third made it nearly one and one-half diameters, which allowed for trimming off the rough edge.

For nearly a year I had charge of the factory, aided by a head die maker who was an expert and we worked as hard as men could to bring results. And once, one morning when we had run for two hours without a break, we began to think we were approaching success, but in a few minutes nearly every body in the third operation press was breaking, and it was hunt for the cause as usual. The first operation usually went through without a break, the second would have a small percentage, but at the third we came to grief. We had other troubles too: for instance we found that the third operation so disturbed the coating of tin the covers would not readily solder on with air tight seams; and that the metal was often so distorted as to make little pin holes in it which made leaks, and the final decision was that the second operation made the metal too brittle to stand the third. Of course it might possibly have been annealed and retinned, but that would have added too much to the cost, though I believe experiments along this line were afterwards tried. But at about this stage of the proceedings life became too strenuous for me, and it was decided that army tactics would be of more value in pushing things along, so a captain in the U. S. Army was engaged for that purpose.

During the time I was in charge of the work, I had applications for positions at different times, from the whole Italian force, even including the inventor himself, although I believe the latter did state that he could only be induced to take a position where he would have charge of at least 1,000 men.

H. F. Noyes.

A Proposed Apprenticeship System—Tools for Apprentices.

I would like to suggest my idea of an apprentice system, which I think would be a great benefit to all concerned. I would put a boy to work on probation for three months, paying him during this period, say four dollars per week. At the end of three months, if he has shown mechanical ability, he would be allowed to sign apprentice papers, and start in to serve a three years' apprenticeship. The first year, he would receive five dollars, the second year six dollars, and the last year seven dollars per week. At the end of the three years, he would receive a bonus of $150 (or a dollar a week) for faithfully fulfilling his agreement. This money would be given to encourage the boys to finish the full apprenticeship and any breaking of the agreement would forfeit the bonus. Perhaps a better idea would be to fit the apprentice out, on beginning his first year, with a tool-chest and the necessary tools required during the first year. The second year more expensive tools would be added and the third year his kit would be completed; the title to the tools being in the company's name until his apprenticeship is completed, when they become the boys property. Fifty dollars would equip a chest in pretty good style, leaving a balance of one hundred in cash for the apprentice at the end of the third year. In this way the company would get the full benefit of the use of the tools, while the boy is taught to use and care for tools which eventually be his own. A system of inspection, whereby the tools would be inspected once or twice a year by the foreman, to see how the apprntice was caring for them, would be beneficial. To encourage the boys to care for their tools, an extra tool as a reward for the best appearing kit would do the trick.

Texas.

Invisible Patches With Butt-Welded Joints on Tracing Cloth.

That sounds a good deal like mending a hole in a cobweb with a piece of moonshine, doesn't it? and a couple of weeks ago I would about as soon have undertaken one job as the other. It is queer how long it often takes to puzzle out the solution of some little problem, one which seems well nigh impossible at the start but in the end proves so simple and easy that we wonder how we could have been so dense as not to see it sooner.

Ever since writing that article in which I remarked it was a pity no one had invented a drawing and tracing paper with removable sections, so that blanks could be inserted where alterations were needed, I have had the idea in mind. Talk about "long felt wants," was there ever one more long drawn out and painfully felt than this? Think of being obliged to copy a large and intricate drawing or tracing just because some little section that was too large to be erased must be altered; and all because no one has invented a paper that could be taken apart and put together, or patched. But I find the fault was not in the paper after all, one sort can be patched about as easily as another and even the gauzy tracing cloth has yielded to my efforts. I do not know but I may yet try the torn cobweb some bright moonlight night.

I got the first faint suggestion of the scheme from an article in *Machinery* This told how tracings on bond paper could be altered by cutting out the defective portion, cutting a patch a little larger than the opening and pasting it on the backside of the drawing, then filling in the corrected portions of the drawing. I tried this plan but did not like the results. There was a pale—almost white—streak surrounding the patch on the blueprint and if a figure came over this it was almost or quite illegible. Then too, the "lap-welded" joint at the edge of the patch did not work very well under the pen in inking.

After that I tried cutting out a patch that just filled the opening in the tracing and fastening it in place with Denninson's transparent gummed tissue applied to the back. This was a big gain over the tapped joint and would answer very well where the appearance of the blue print was not of so much consequence provided it were perfectly legible, but I wanted a patch that should be invisible on the blueprint and I was determined to get as near this ideal as possible before giving up.

Next I tried holding the patch in place by gumming a sheet of tracing clath over the entire back of the drawing. This accomplished a portion of what I was striving for; the patch no longer showed on the print for all parts of the drawing were of equal thickness and opacity, but it was too expensive for common use and the tracing cloth would wrinkle and pucker wherever the mucilage touched it. Clearly this way was not what I was in search of, though it did away with the whitish border surrounding the patches.

Here the matter rested for a few days; I could think of no way to prevent the buckling of the tracing cloth nor to get around the increase in thickness and opacity of any sort of a lapped joint, but chance came to my aid. I was doctoring a sore finger with flexible collodion, or liquid courtplaster, and thinking how much nicer it was for the purpose than any material in sheets could be, when it slowly dawned upon me that in that little bottle was the very substance I needed for making invisible patches on drawings and tracings. It was easily applied, cheap, perfectly transparent, flexible, and fairly tough and strong.

I made several trials of it at once, first on bond paper and finally on tracing cloth. The enclosed samples and the blueprints attached, which were made from them, show how completely successful I was. As these prints are all made from blank tracing cloth and paper anything like a patch would be much more noticeable than on a surface broken up with lines running in all directions, but in the case of the bond paper it takes sharp eyes to locate the outlines of the portion which has been cut out and replaced. With the tracing cloth there is a fine opaque line at the joining, caused, I imagine, by the crushing of the threads under the knife edge, and this is not quite invisible in the blueprint, though so nearly so that one would not notice it unless he were looking for it. The two prints from a working drawing show that in the case of the gummed tissue the degree of printing

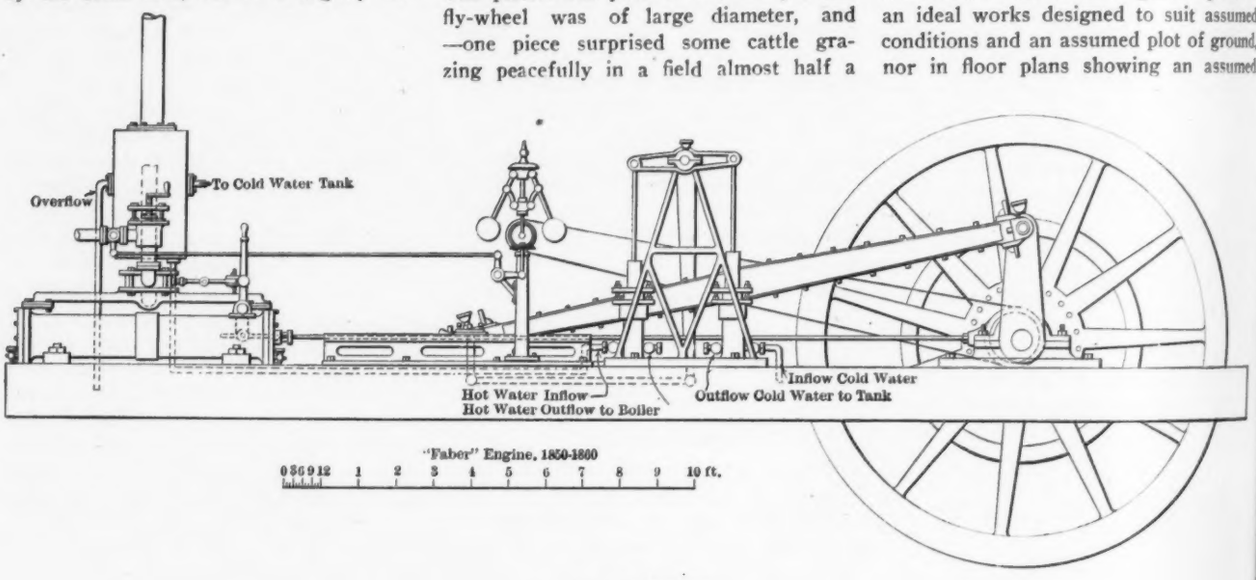
materially affects the visibility of the patching.

I believe that absolutely invisible patches can be made on bond paper with collodion, (as far as the blueprints are concerned) it depending only on the skill with which the patch is fitted to the opening, which it must fill completely without lapping the edge. Here is a helpful hint I got from a skilled woodworker for getting the patch to exactly fit: Place the patching paper under the drawing and then cut through both at the same time with a sharp knife point. If firmly held in place both outlines must be alike in size and shape. E. R. PLAISTED.

[The samples certainly show results that are all that could be desired.—Ed.]

Odd Types of Stationary Engines.

Mr. Osborne's article and drawing at page 9, pertaining to an old "Buckeye" engine, recall two built in the early fifties by the same firm, but of a slightly different design from the one described by him.


Overflow
To Cold Water Tank
Hot Water Inflow
Hot Water Outflow to Boiler
Inflow Cold Water
Outflow Cold Water to Tank
"Faber" Engine, 1850-1860
0 3 6 9 12
1 2 3 4 5 6 7 8 9 10 ft.

AN OLD ENGINE.

These were in flour mills at Irwin and Larimer, towns of western Pennsylvania one mile apart and 21 and 22 miles, respectively, east of Pittsburg, Penn. They were fitted with a steam-chest and valve on each end of the cylinder. These steam-chests were united by a tee through the straightway of which the valve stem passed, and the side-outlet connected with the boiler in the usual manner.

The engine in the mill at Irwin once figured in a runaway which fortunately injured no one. An accident to the governor, and an engineman attending to other duties in a remote part of the mill formed an unfortunate combination, and the speed increased to such an extent that the fly-wheel proved alarmingly true to its name and went out in several pieces through the roof and alighted in various places in the surrounding country, scrapped about 1868; and soon after, the one in the other mill was replaced by an engine from the Buckeye company, of an almost similar type to that described by your "Oil Country" correspondent.

Another type of engine installed extensively during the fifties and early sixties in mills, salt works, and machine shops, within a wide radius of Pittsburg was the "Faber," built by William Faber & Co., in a shop which stood at the foot of the high hill near the present Pittsburg Union Station of the Pennsylvania Railroad.

As will be seen by reference to the accompanying drawing, the proportions of the Faber engine seem odd. The cylinders were from 8 to 10 inches in diameter, with a stroke of from 66 to 72 inches. The steam ports and valve seat were cast in a separate piece and this was bolted to flanges at each end of the cylinder. The piston was packed with hemp. The fly-wheel was of large diameter, and —one piece surprised some cattle grazing peacefully in a field almost half a mile from the mill. This engine was like the connecting-rod, was partly of wood and partly of iron. Instead of a continuous iron frame, two hugh timbers were used and the various parts of the engine were bolted to these. Two vertical pumps, one to supply cold water to a tank, and the other to take this water after it has passed from the tank to the heater, and force it into the boiler, were driven by a walking beam, connected to the crosshead.

One at least, to my knowledge, was built with two cylinders and operated a sawmill, but was later rebuilt by the Fabers on their standard single-cylinder plan. The speed at which these engines ran was slow, probably not exceeding 75 revolutions per minute, but their performance seemed satisfactory to their users.

However, the requirements of modern machinery, especially in flour mills, called for engines of a different type, and as rapidly as "old reliables" required extensive repairs they were replaced by engines of more modern construction, until at this time the larger number have passed into the scrap heap,—that great cemetery of worn out engines.

Yeadon, Penn. C. H. CARUTHERS.

A Book Review Criticized.

I was somewhat amused at the notice of my book, Modern Machine Shop Construction, Equipment and Management, at page 196, and wish to present my compliments to the reviewer and to say that I was not before aware of my ability for making a title page so attractive as to require eleven lines of a notice to describe it, while the other 342 pages of the book could be covered by the succeeding twenty lines. However, one never knows what he can do until he tries.

The reviewer further on says he "has little faith in the value of general plans of an ideal works designed to suit assumed conditions and an assumed plot of ground, nor in floor plans showing an assumed equipment of tools which fit their places like the squares of a checker board. It is too easy to make them thus fit,'" etc.

He will doubtless agree that in a work like this conditions *must* be assumed, while in practice they already exist. I have designed several plants all the way through from the ground to the equipment and claim to know something of practical conditions; yet in the arrangement of the tools shown on page 130 of the book I found that they did not "fit their places like the squares of a checker board," and that it required over a week of hard work and hard study to make them "fit" as they are shown.

It is always easier to criticize than to get into the harness and do the work. There are many men who think that they can run a paper much better than the editor, and perhaps it is the same way with writing books.

I can inform the reviewer that there have already been two plants planned from the chapters in this book when they were published in *Machinery*, and several plants have been re-arranged and added to from information gained from the same source.

OSCAR E. PERRIGO.

A Taper Gage.

After a thorough investigation of H. K. Harring's criticism of my taper gage at

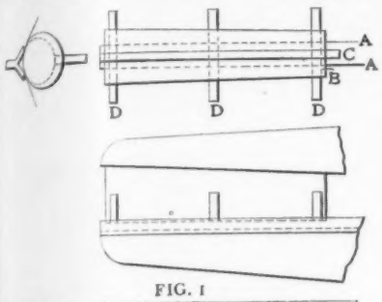


FIG. 1

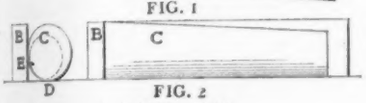


FIG. 2

A TAPER GAGE.

page 853, Vol. 28, Part 2, and of the editor's remarks, in a foot-note to my reply to that criticism, at page 95, Vol. 29, I have found that the editor and Mr. Harring are wrong in their statements in regard to the matter. Mr. Harring says: "Any section of a cone in a plane parallel to and at a distance from the axis is, in outline, a parabola, consequently, it is impossible to rest a cone on two parallel edges any appreciable distance apart." The editor, in the foot-note, says: "The mathematical fact cited by Mr. Harring makes it impossible that a taper shank can lie in a V and fit all the way along."

As a matter of fact, a section of a cone in a plane parallel to and at a distance from the axis is in outline a hyperbola. In my description of the gage I said it is made "of a size to suit the requirements."

Since the publication of my critics' opinions I have made tests in the presence of a number of readers of the AMERICAN MACHINIST on a taper gage of my own, which I made shortly after the one I referred to in my reply. The opening of the V on this gage forms parallel edges $^{5}/_{16}$ inch apart, its gaging capacity being tapers from ½ inch to 1½ inch diameter at the large ends. A taper shank in proper proportion has a length equal to four times its largest diameter, exclusive of the tang or reduced end.

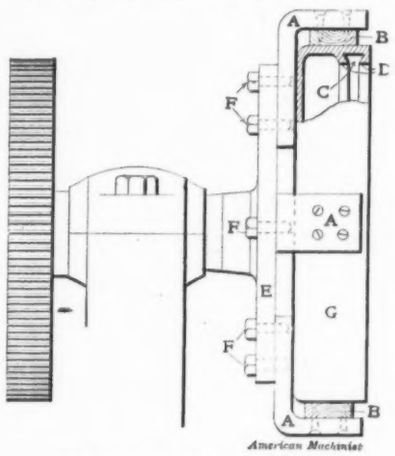
In the repeated tests of the gage with tapers of the sizes mentioned, I found that a hyperbola developed $^{5}/_{32}$ inch from the axis of an elongated cone, 1½ inch diameter at its base, with a taper of ½ inch per foot, is 28½ inches long from base to apex, and has practically straight outlines along 27 inches from its base. Further, all the tapers tested held three strips of paper, ⅛ inch wide, placed across the parallel edges of the V, one at each end, and one in the center, when brought in place under the blade, as shown in Fig. 1. *AA* are the parallel edges of the V on the gage, *B* is the taper piece, *C* the blade of the gage and *DDD* the paper strips, which showed that the tapers rested on the parallel edges close enough for all practical purposes. I also placed a strip of paper under one end of the taper at a time, and the gage clearly showed the difference.

Fig. 2 demonstrates that is is possible that a taper shank can lie in a V and fit all the way along. Let *A* be a surface plate and *B* a parallel block. A true taper, *C*, will rest all the way along on the plate, because its sides or elements are straight; therefore, if a taper comes in contact along its entire length with the plate at *D*, there is no reason why it should not have the same contact with the parallel block at *E*, because the conditions at *E* are equal to those at *D*.

H. E. R. MANBRAND.

Large Work on Small Tools.

There have been from time to time articles on doing large work on small tools. All of us who have either run, or been "dragged up" in small shops have had ex-



THE CHUCK AND THE WORK.

periences of this kind. In all the articles I have read no mention has been made of wooden chucks for holding the work. During my apprenticeship it was my good fortune to have the *entre* into the private workshop of an amateur mechanic. I may mention that there exists in England an amateur class which we do not have in the United States. Over there many men of means with mechanical tastes equip workshops, hire the best men that money can procure and go through a course of instruction at the hands of these men. The man into whose shop I used to go in the evenings and holidays was one of the best all round mechanics I have ever met. In his shop I got a knowledge of materials not common in machine shops—ivory, meerschaum amber, hard rubber, etc., etc. I also learned the use of wooden chucks.

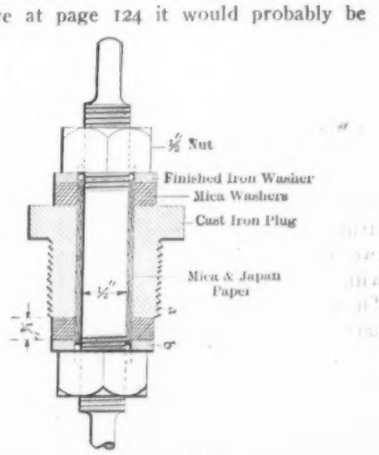
While employed some years ago in the repair shop of the Gloucester Mfg. Co., the foreman gave me two large gray iron covers to turn. The company used large quantities of water while bleaching and dyeing piece goods preparatory to printing. The water was pumped from the Delaware river by two large pumps. These were in a building out on a wharf near the river. The pumps were of ancient design and there was a great deal of polished work about them. Owing to the dampness of the location the covers had to be polished every day to keep them respectable. The master mechanic objected to painting the bright covers but decided to coat them with white lead and tallow and make a pair of gray iron covers to slip over them. On state occasions these covers could be easily slipped off, the white lead and tallow removed and the pump covers displayed in all their pristine brilliance. The covers were about 60 inches outside diameter. The largest lathe was about 66 inches swing, but the largest face plate was only 54 inches diameter. I made four angles A of one inch by 6 inch flat iron and fastened with screws four maple blocks B to these angles, which were secured to the face plate E by the tap bolts F. I then bored the blocks and forced a cover into them.

I will never forget the consternation of the foreman when he came into the shop and found me taking a good-sized cut on the part marked D which I was boring to slide easily over the pump cover proper. The dovetail C was turned out and a piece of rubber, square in section, was forced into it. The second cover was a little smaller than the first so I put a center punch mark in the center of the inside of it, and put a bar between it and the tail centers to prevent it jarring out. Any one who has not used wooden chucks will be surprised at their pulling power. For holding odd shapes or flimsy work that a jaw chuck would distort they are invaluable.

DIXIE

Gas Engine Troubles.

In reference to the article headed as above at page 124 it would probably be



A SPARK PLUG.

better to make the igniter as shown in the attached sketch. The trouble with the plan shown by Mr. Graves would be lack

of surface. In any sort of insulating it is the creeping distance across the surface that counts rather than the thickness. The voltage in an igniter is very high and must be to produce a proper spark. As deposits of dirt collect on all surfaces, the surface distance must be relatively large. With relatively clean surfaces the construction shown will easily stand 10,000 volts. The principal difference between this construction and that shown by Mr. Graves is in the surface. The strains would occur between washer *b* and plug *a* all around and as this would be over ¼ inch no trouble would occur. The insulation on the bolt should be of paper and mica in alternate layers. If the bolt gets very hot paper will carbonize which will not, however, effect insulation. The sleeve should extend up through the mica washers and to take care of defective insulation at a point in which Mr. Graves' design is defective as the creeping distance along the surface will again be ¼ inch.

F. W. HARRIS.

A Spring-Testing Machine.

We had a number of instruments on the market with a spring *A* shown in the sketch. A good many returned the part with the spring in it; some were too weak and would not stand the pressure after the instrument had been in use for some time, some were too hard and would break off. To overcome these troubles a gage was suggested. We at first thought it rather expensive to build, but since it has been built and used we have never regretted the outlay. It would not pay to make it if there were only a few hundred to be gaged, but it was designed for a certain class of work of which there were several hundred used daily. It was to gage the same spring several times at intervals of a week or ten days, with a full pressure, then with single and double weight to the limit lines.

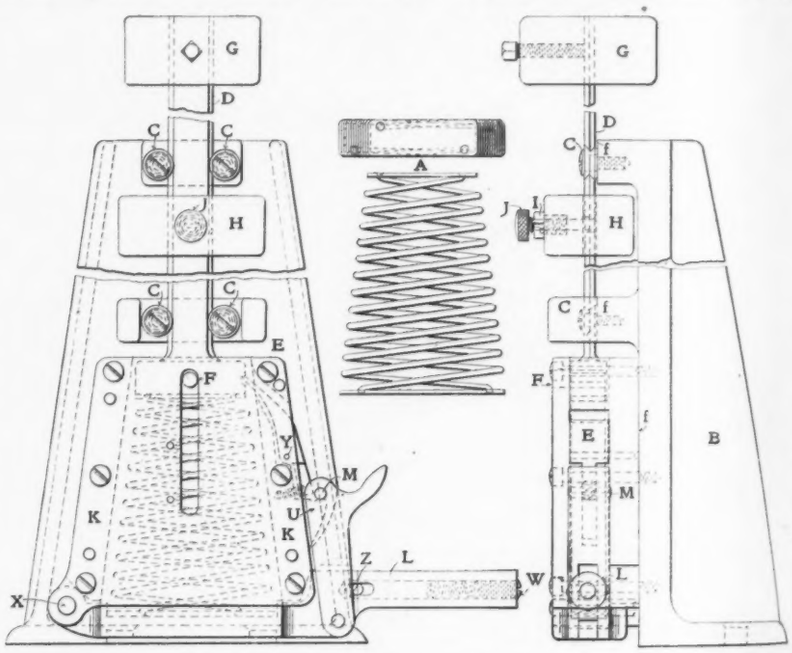
The assembled drawing of the gage will be seen in the sketch, parts of which are as follows: *B* is a gray-iron frame with two ribs on the back for support, and two holes on the bottom of the casting countersunk for wood screws, so that the frame can be screwed down to the edge of a bench when in operation. The front of the frame is planed at *F* to have a good straight surface for the rollers and side strips when screwed in position. In the two lugs are four rollers *CCCC* placed with a shoulder screw in the center. These rollers are made of tool steel hardened and drawn to a straw color. They have a 45-degree groove in the middle and are a running fit in the screw. Between these rollers slides a bar *D*, made of machine steel case-hardened. On each side it is shaped to fit the groove in the roller. On the bottom end of the bar, the width and length is under the size of the spring *A*. On the right side is cut a groove to engage the latch *E*. In the middle a hole is drilled and a pin *F* driven in. This registers the pressure of the springs.

On top of the bar a weight *G* is fastened with a set-screw. This is planed down until it registers the correct lightest pressure. In the middle of the bar hangs another weight *H*. This in conjunction with *G* registers the greatest pressure required, as the spring must travel a distance of 1 3-16-inches and still not be too stiff. The weight *H* lies freely on the lower lug when the first weight is in use. In the center of *H* is a bushing *I*, screwed in with a T-groove cut on the outer end. The nurled plug *J* fits the hole in the bushing freely, and has a pin in the center of the plug *J*, which fits easy in the T-groove of the bushing. Between the pin in the plug and the nurled head is placed a spiral spring; this keeps the plug from coming in contact with the bar when not in use. By a slight pressure of the fingers and a turn to the right the weight *H* is secured to the bar when in operation.

On each side of the fixture is fastened a strip *K*, secured with three screws and two dowel-pins. These strips are made of machine steel case-hardened. In the lower left-hand side the strip has a slot milled in the middle to fit the end of the lever *L*, with a hole in the center and a pin *X* driven in. The other strip is cut out in the upper end to give plenty of room for the latch *E*. On the side of the strip a narrow tongue is milled for the hammer pin *M* to slide on. The latch *E* is made of tool steel hardened and drawn to a straw color. It is a free fit in the strip and hangs on a pin *Y*. On the bottom it is pressed outward by a light spiral spring in holes in the latch and the strip. On top of these strips *K* is placed a plate held by six screws and four dowel-pins. In the center is an elongated slot in which the pin *F* slides. On its face six lines are graduated. On each side of *O* are the limit lines. The lever *L* is made of machine steel case-hardened. The left end fits the slot in the strip *K*. The hole in the end is a turning fit on the pin *X*. In the middle of the lever *L* is milled a seat for the spring *A* to stand in. On the other end of the lever is a round handle. In the center of the handle is drilled a long hole, in the bottom of the hole slides a T-pin *Z*, hardened and drawn. In the extreme end a screw is fitted, between the screw and the pin is a spiral spring, this forces the T-pin down.

In the middle of the handle fits the hammer *V* with a hardened pin in both ends. The spring in the handle must be stronger than the latch spring so that the latch will come out of the groove. By raising the handle up the hammer pin strikes the lower end of the latch, forces the point of the latch out of the groove in the bar and down it comes automatically and gages the spring with the first weight *G*. Raising the second weight *H* up to a line designated on the bar, a slight pressure with the finger and a turn to the right secures it to the bar, down it drops again to the extreme limit lines.

To unload, grip the handle with the right hand with four fingers on the handle, with outward pressure on the hammer with the thumb, the pin *M* will slide off *L* and the lever will drop down. With the left hand take the spring out, unloosen the second weight by turning the nurled plug to the left, raise the bar up until the latch engages. Now place another spring in the bottom of the lever; with a slight bending of the spring it will go in the gage when the lever is raised to position. The spring *A* is composed of two pyramid



A SPRING-TESTING MACHINE.

springs riveted together with sheet-steel plates on top and bottom. After hardening the oil is burned off until it registers the right strength. Some springs require only one burning while others need three.

B. R. ZANGE.

A Marine Generating-set Breakdown—Cause, Effect, and Repair.

A big freight steamer had just docked All hands on board were busy with the operations customary at such a time. On deck the cargo men, at each hatch, had started the freight hoists, and were rigging up the gear required to lift the freight out of the holds. In the engine room the engineers were shutting down the main engine stop valves, and changing over the auxiliary engines exhaust steam connection from the main to the auxiliary condenser. In the firerooms the main stop valves on the boilers had been shut, and the auxiliary steam stop valve opened on the main boiler, which was to be used for auxiliary purposes while the ship was in port. Everything was going along smoothly, when suddenly there arose a rapid succession of crashes from the dynamo engine, evidently caused by water in the cylinder. The attendant hurriedly opened the drains and shut the stop valve on the engine, but was too late to prevent the engine being badly damaged.

The engine was of the vertical inverted type, direct coupled, with two cylinders 10 inches by 6 inches stroke and ran about 350 revolutions per minute. The cylinders and their slide-valve chests were in one casting and were supported from the soleplate on four round, hollow, gray-iron columns, about 4 inches in diameter. The back columns and the guide plates were in one casting. Each column had two bolts 1⅛ inches diameter in the upper flange to which the cylinder feet were secured. The four columns were broken through close to their upper flanges. One piston rod was broken and when it let go the piston sailed through the top cylinder head carrying that away also. One slide valve stem was also broken. The piston rod, cylinder head and valve stem were replaced by spare parts which, fortunately, were in stock on board, and the cylinders were repaired in the following way. A pattern was made, of the shape shown at Fig. 1, and eight pieces were cast off this in brass. One of these was placed under each end of the column flanges and secured to the column by four tap bolts ⅝-inch diameter. The original column head bolts were replaced by longer ones which passed through the upper column flanges and were secured by nuts under the brass patches. The repairs were completed in one and one-half days. The engine was then started and ran in this condition for several months until a crack showed in one of the cylinder feet at *A*, Fig. 5. That corner of the casting was secured by making an eyebolt, as shown at Fig. 2, and securing it to the cylinders by a tight fitting tapered bolt which passed through the eye and was screwed into a plug hole in the front of the cylinders. This hole had been originally intended for a drain connection but the drains had been afterward fitted on the back of the cylinders and the holes plugged, leaving more room at the front for overhauling the engine. This eyebolt was passed through the cylinder foot, column flange and patch and secured under the patch by a nut, the shoulder being left 1/16-inch clear of the cylinder foot for draw. The whole arrangement proved satisfactory, so far as securing the cylinder was concerned, but there was still a considerable amount of vibration about the engine. Eventually the flaw ran right round the cylinder foot—see Fig. 5—after it had been working about 6 months. A patch of brass was then made, as shown in sketches Figs. 3, 4, 5, tapering from ½-inch to ⅝-inch thick around the cylinder walls, the foot forming part of this patch. The patch was secured to the cylinder by 10 tap bolts ½-inch diameter, disposed as shown, and a 1-inch bolt in the plug hole previously referred to. The engine has been running in this condition for several years and has given no further trouble.

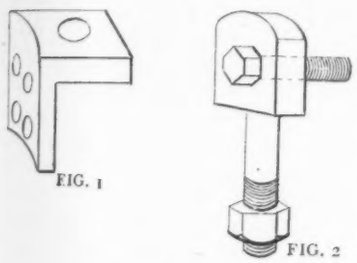


FIG. 1

FIG. 2

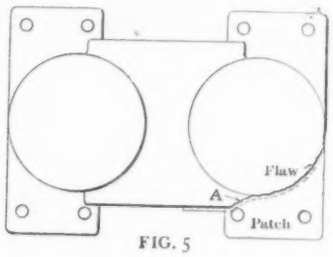


FIG. 5

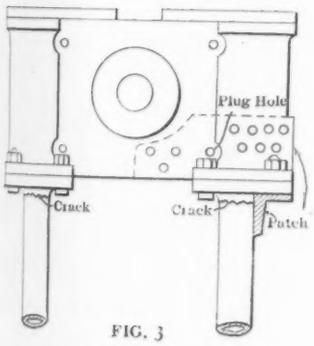


FIG. 3

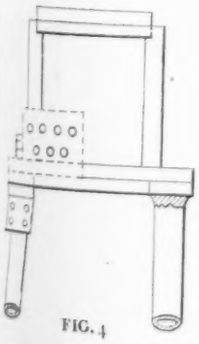


FIG. 4

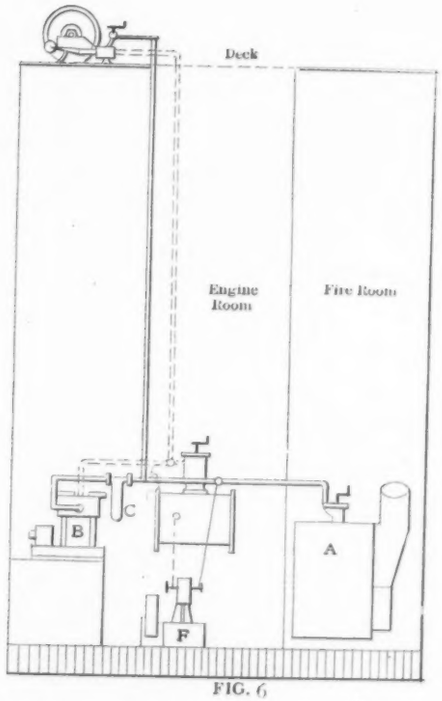


FIG. 6

BREAK-DOWN OF AN ELECTRIC ENGINE.

An inquiry was held into the cause of the accident and the following facts were ascertained:

1. The accident took place just after the stop valve on the boiler was opened.

2. The steam pressure in the boiler had fallen rapidly just after the valve was opened. The blower had been immediately speeded up and the fires forced in an attempt to maintain the pressure.

3. The water in the boiler had gone down rapidly after the valve was opened.

4. The back pressure on the exhaust had risen quickly just before the accident.

5. The circulating pump for the auxiliary condenser, which was situated between the boiler and dynamo engine had slowed down just before the accident.

6. The water in the boiler was not abnormally high when the stop valve was opened.

7. A number of the deck hoists had

been started shortly before the smash.

8. The draining arrangements of the piping and traps had proved fully adequate up to this time and examination subsequent to the accident showed them to be in good working order.

9. The attendant on the engine had shut the stop valve and opened the drains as quickly as possible on hearing the noise in the cylinders.

The following suggestions based on the foregoing facts were offered as probable causes of the accident:

1. The stop valve on the boiler had been opened too quickly and the reduction in pressure had caused the boiler to prime. The water had gone along the pipe, flooded the trap, the drain pipe of which was too small to clear the trap quickly enough of the large volume of water and it had gone into the engine.

2. A number of the cargo hoists had been started simultaneously just after the valve was opened, reducing the pressure in the boiler, and the sudden rush of steam had lifted the upper strata of water in the boiler—as the water therein had been in a quiescent condition just before the valve was opened.

3. The blower had been started too quickly and the fires being forced just after the boiler was connected up caused it to prime; as the steam generated in the lower strata of water was unable to force its way through the overlying quiescent water quickly enough it lifted the water bodily when the pressure on top was reduced.

4. Some of the water was the result of condensation in the deck-hoist steam pipes. This water had been lying in the deck pipes. When the hoists were started this water was passed through the pipes with the exhaust steam. It had so much force due to the head (about 35 feet) from the deck that it overcame the pressure of the exhaust steam issuing from the electric engines—situated in the lower part of the engine room—and flowed back into the cylinders of the electric engine during the latter part of the piston stroke and before compression took place.

5. There had also been a slight amount of water entrained in the steam from the newly opened boiler, which had got into the cylinders and caused the creaking noise there. The attendant had opened the drains partly but had shut the stop valve too much or altogether and the engine still revolved owing to the momentum of the heavy flywheel. Just then the water had come down from the deck and got through the exhaust into the cylinders, as in paragraph 4.

6. The steam stop valve on the engine had been shut too suddenly and the sudden reversal of the strains on the working parts of the engine due to them being dragged by the flywheel, instead of pushed by the steam or vice versa, assisted to some extent by water in the cylinders, had caused the smash.

7. It remained an open question whether the rise in the back pressure was due to the auxiliary condenser circulating pump slowing down, or whether the pump slowed down due to the back pressure, or through water getting into its cylinder from the newly connected boiler, or if the back pressure in the condenser was also due to a rush of steam and water from the deck.

Instructions were issued that in future the deck hoists had to be started up slowly before the ship docked so as to give time for any condensed steam to be trapped and drained. The boiler fires were not to be forced too hard immediately after it was opened even if it took a little longer to recover the normal pressure. The engines were to be shut down gradually if possible in case of water in the cylinders.

Whether this instruction covered the source of the trouble I do not know but there has been no further episodes of a like nature in that ship.

Fig. 6 is a sketch of engine and fire room in which *A* is the boiler, *B* the dynamo engine, *C* the trap, *D* the auxiliary condenser, *E* the freight hoist, *F* the auxiliary condenser circulating pump.

The steam piping is shown in full lines and exhaust in broken lines.

MANU FORTI.

The Liability of the Patternmaker.

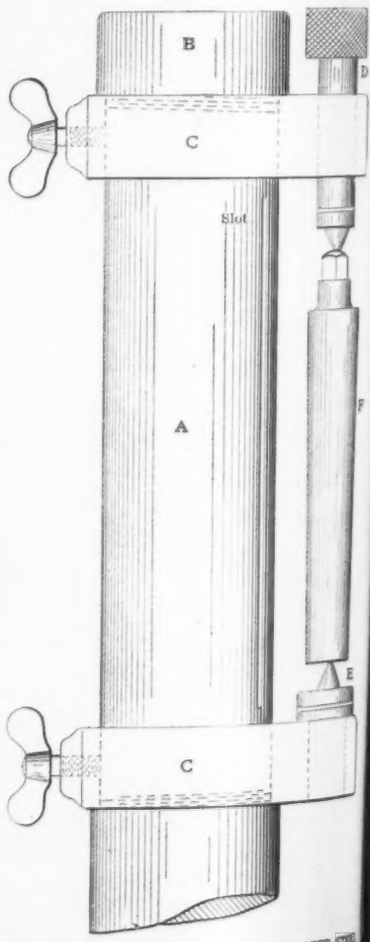
The article at page 94 by "Nemo" reminds me of more that I might say on the subject. I think there is no question that the patternmaker should correct the pattern. When the customer gets the pattern it is his business to see that it is right. If he chooses to assume that it is so without satisfying himself, he thereby takes upon himself the responsibility for a correct casting. If I send a pattern to a customer and tell him to check it up and discover any error before making castings and he fails to do so, I claim that the responsibility for a poor casting is his and not the patternmaker's, for by discovering the error first he could have had the pattern corrected, and then get a good casting.

I will relate another occurrence along this line. I made a piston pattern for G. and B., partly from an old casting and partly from a blue-print. Some of it was like both of them; but all of it like neither one. Realizing how easy it could be to have it wrong, I marked the pattern on delivery, "Check this up." They failed to do so, or else merely glanced at it. When they got the casting ready to go to work on it, they found six pins missing that should have been there to hold springs for forcing the rings out. They did not show on the old piston and were shown by a dotted line only on the blueprint. As the casting was for a repair job and urgently needed, they drilled it out and put in the six pins of ⅝ cold rolled stock 1½ inches long and deducted $3.50 from my bill for doing it. I asked them if they had checked up the pattern. They said, "No, we told you what to make and the pins showed on the blueprint, and we therefore expected you to put them on the pattern." I asked if they especially told me to put the pins on. They said, "No," that I ought to know enough to do it without telling. I replied that perhaps I ought but I didn't, as I did not consider mind reading a part of the patternmaking art, and in closing said, "you still owe me that three-fifty. While you don't have to pay it you owe it just the same."

We all get it rubbed into us occasionally and the other fellow doesn't always pay the bill. J. L. GARD.

A Device for Hardening High-Speed Steel Reamers.

One of the drawbacks in making long reamers of high-speed steel is the tendency that they have to bow and become distorted in hardening. This can be avoided and highly satisfactory re-



A DEVICE FOR HARDENING HIGH-SPEED STEEL REAMERS.

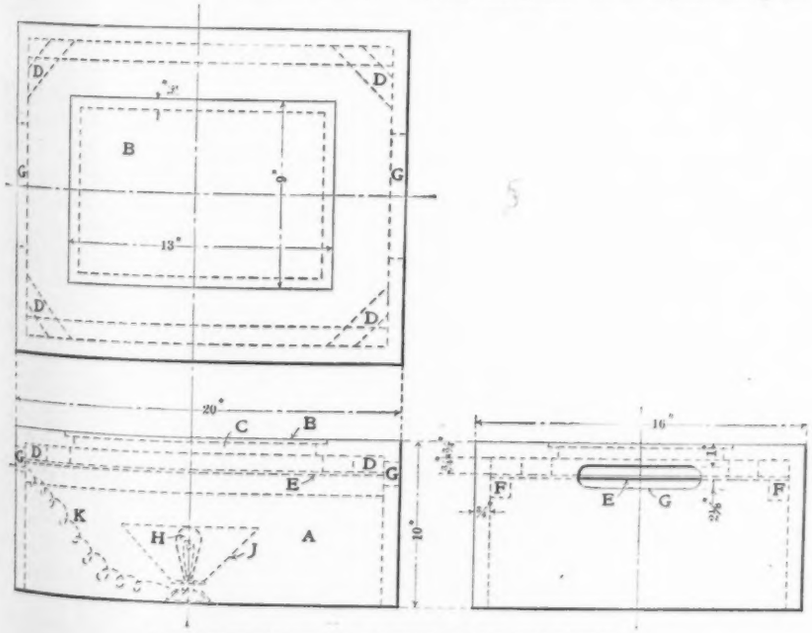
sults may be obtained by using the rig shown. *A* is a piece of 3-in. pipe coupled to the blast pipe. A slot about 1/16 inch wide is cut almost its entire length, so as to allow the air to strike the reamer its full length. *B* is a 3-inch cap screwed up tight. *C C* are support brackets held firm by thumb screws. The upper one can be lowered to accomodate different lengths. *D* is a sliding fit in the upper bracket *C*, so as to allow it to be moved up or down while inserting the reamer *F* in position to be hardened. *E* is a snug fit in the lower bracket *C*. When the reamer is headed to the right degree and placed in position, air is turned on and as it leaves the slot and strikes the teeth at an angle it causes the reamer to rotate very rapidly thereby cooling it evenly. As both *E* and *D* have ball bearings it will be found necessary to exert a slight pressure on *D*, so as to check the speed. The device is not original with me but was seen while visiting a large locomotive shop where it was doing excellent service. It should be used in a vertical position.

SNIBLETS.

A Drawing Board for Patent Office Drawings.

In the accompaning sketch is shown a style of drawing board which has been found very useful for making final patent office drawings from original drawings, as it saves much time and unnecessary laying out.

The device consists of a wooden box *A*



A DRAWING BOARD FOR PATENT OFFICE DRAWINGS.

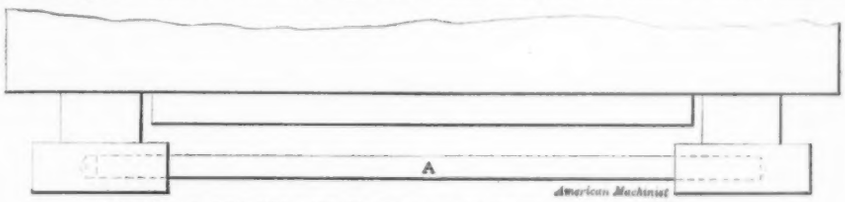
with a piece of plate glass *B* fitted into its top as shown. Four cleats *D* are fastened in the corners of the box and a piece of ordinary window glass *E* cut to the size of the inside of the box is placed up against these and held in place by the strips *F*. The holes *G* are air holes, and the window glass *E* is so placed as to be in the center of these holes, as shown in the end view. This arrangement keeps the heat from the light *H* away from the work which is placed over the glass plate *B* and at the same time makes the task of copying the work as easy as though tracing cloth were used instead of thick patent office paper. The light used can be a small incandescent light with a reflector *J*, running the wire *K* in through one of the holes *G*.

This device may also be found useful in tracing blueprints and other similar work.

B. R. JUDD.

How to Keep the Dividing Head Bolts from Turning.

The enclosed sketch shows a method for preventing the bolts of the dividing head



SCHEME TO PREVENT THE DIVIDING HEAD BOLTS FROM TURNING.

of the milling machine from turning around, thus making it comparatively easy to place that piece of apparatus on the platen. This subject was discussed in your columns nearly ten years ago, but the devices then illustrated did not seem to appeal to me very strongly, so I fixed up the bolts in my dividing head as shown herewith. *A* is a piece of 3-16-in. round steel rod driven tight in one bolt head, and a free fit in the other, the head in which it fits tight being the first one to enter the T-slot of the platen when putting on the index head.

This device has been in constant use about ten years, and no fault has been found with its operation. The nice point about it is its simplicity, the few minutes spent in its original construction being saved many times over in its use. The 3-16-in. holes in the bolt heads do not seem to weaken them, as this index head has been subjected to rather rough usage at times without the bolts showing any signs of weakness. This is an excellent way in which to fix up a machine of the old type; perhaps in the later models the makers may have provided against the inconvenience of a bolt head twisting around, but if they haven't it's about time they did.

E. N. ANDREWS.

Calculating Cone Pulley Speed.

Referring to Mr. Millar's reply, at page 683, Vol. 28, Part 2, to my letter on the above subject (in which I stated that the real reason for the adoption of the flatter cone was the increase of power thus obtained and not the increased lap of the belt) let me begin by quite accepting his criticism so far as it applies to the exact wording of my letter.

My statement was to the effect that "By increasing the diameter of the bottom step of the cone, the slowest belt speed is also increased," as there are two counter speeds, the belt must be on the small step twice throughout the range. Of course, as Mr. Millar says, it is impossible to increase the slowest speed of the belt when using the slow counter speed, but, when using the fast, for the same position of belt, the speed is vastly increased. However, thanking him for his correction on this point, I will go a little further.

Mr. Millar took the trouble to plot all the belt speeds for the different arrangements of counter speeds. As power supplied to a machine is proportional to the belt speed, it is quite correct to consider these two curves as the relative horse powers supplied for both arrangements.

I have not taken the trouble to check the actual figures, but, assuming them to be correct, it will easily be seen that the average horse power supplied throughout the whole range by using the full cone range first, is greater by about 25 per cent. than by changing the counter speeds between the steps of the cone. This gain is quite sufficient to justify the adoption of the flatter cone, whether it looks better or worse. Appearance in this particular instance—like the flowers that bloom in the spring—has nothing to do with the case.

Again, although the remark is irrele-

vant to the point under discussion, Mr. Millar says that more designing is done by appearance than by plotting diagrams on squared paper. Quite so, but the comparatively small use of squared paper, it must be remembered, does not show any inadvisability of adopting this method of comparison; it merely shows complete ignorance or indifference as to what can be learned from the plotting of curves. Also, designing, as I understand it, and as it is practiced by the best makers, is, first, to ascertain what is the correct thing to use, and then if necessary to modify this to please the eye, taking care that such modification does not impair the utility of the part under consideration.

Salford, England. W. OWEN.

The Mathematical Analysis of the Strength of Belting.

A number of text-books which have been published in the last few years contain what appears to be an erroneous form of the equation for the strength of belting, but so far as I have seen, no notice has been taken of it. As the error seems likely to be perpetuated in the absence of any discussion of the matter, I should like to point out briefly what the error is and to show the correct form of the equation.

A book fresh from the press gives the equation

$$\log_e \frac{T_1}{T_2} = u\left(1 - z\right)\theta$$

which might be written

$$\frac{T_1}{T_2} = \epsilon^{\,u(1-z)\,\theta}$$

where T_1 and T_2 are the belt tensions on tight and slack sides, u the coefficient of friction, θ the angle of contact, and z a quantity whose value is $12\,\frac{w\,v^2}{g\,t}$ and which is intended to give the correction for centrifugal force at high speeds. In the latter expression w is the weight of the belt per cubic inch, v its velocity in feet per second, g is gravity and t the allowable working tension of belt per inch of cross-section.

The correct form, as given by Bach in his "Maschinen Elemente," is, with the notation changed to agree with the above,

$$\frac{T_1 - \frac{12\,w\,v^2}{g}}{T_2 - \frac{12\,w\,v^2}{g}} = \epsilon^{\,u\,\theta}$$

in which the correction for centrifugal force is subtracted from the belt tensions instead of appearing in the exponent of ϵ.

The mistake seems to have arisen in getting the value of z.

The centrifugal force is given as

$$C = A\,\frac{w\,v^2}{g\,R}$$

It is stated that A, the area of the cross-section of the belt, is $\frac{T}{t}$ where T is the variable total tension in the belt and t, as above, the working tension per unit area of sectional area, which is by implication, constant for any given set of conditions. At any rate when the substitution is made in the formula for C we get

$$C = \frac{T}{t}\,\frac{w\,v^2}{g\,R} = \frac{12\,w\,v^2}{g\,t}\cdot\frac{T}{r} = T\,\frac{z}{r}$$

and z is treated as a constant and T as a variable.

This would indicate that the area of the belt section—and therefore the centrifugal force — varied directly with T from T_1 to T_2, which is absurd.

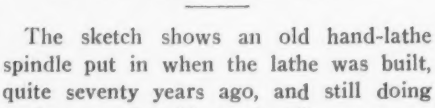
The difference between the results obtained from the two formulas may not be great in most ordinary cases, but where there is no gain in ease of manipulation or otherwise, there would seem to be no sufficient reason why the correct formula should not be used.

JOHN B. PEDDLE.

Rose Polytechnic Institute.

An Old Hand-Lathe Spindle.

The sketch shows an old hand-lathe spindle put in when the lathe was built, quite seventy years ago, and still doing business at the old stand. The cone was formed on this spindle in a reversed position from modern practice and fitted in a



AN OLD HAND-LATHE SPINDLE.

hardened bushing (I suppose of tool steel) in the main bearing of the headstock, the spindle being hardened also. In the back part of the headstock a pointed set-screw was fitted, having a jam nut (not shown) to keep it in place, this set-screw being the only bearing and support for the back end of the spindle, and like that end being hardened. A friend who has had the old lathe under his eye for 25 years informs me that it is just as I left it, and I left it as originally built. The last time I saw the lathe the spindle was running *true* on the set-screw. The lathe is now used for light drilling. The old machine was built on honor, was it not?

WALTER DE SANNO.

Gas pipes of paper, as tried in Europe, are reported to have advantages, and are very tight and cheaper than metal. In making them manila paper is first cut into strips, having a width equal to the length of the section. The strips are dipped into melted asphalt, tightly wound to the right thickness around a core of iron rod or pipe, and coated under pressure with a layer of sand. The core being then removed, the outside of the pipe is waterproofed.—*The Paper Trade Journal.*

The February Reunion of the American Society of Mechanical Engineers.

The February reunion of the A. S. M. E. was held at the Society house the evening of Tuesday, February 27. The paper of the evening was by Past President James M. Dodge, the subject being "The Results of the Use of the Taylor System of Shop Management" at the works of the Link Belt Engineering Company.

Mr. Dodge began his address by saying that the Taylor system had now been in operation in these works for a period of about three years, and he proceeded to give a recital of the causes which had led to its adoption. He explained that the work done was of a very miscellaneous character, with no large duplicated lots of parts. The company formerly prided themselves on their methods and system. They regarded themselves as very progressive and they were very well satisfied indeed with their shop methods and organization. His interest in the subject began with the news which came to him of the remarkable performance of the Taylor-White steel at the Bethlehem Steel Works, and he went there to see it in operation. The results were so astonishing that he was at first somewhat dazed, and it was some time before he took in the full significance of what he had seen. Returning home he explained his observations to their tool maker, of whom, with many other shops, he had "the best in the world," and the tool maker declared that the results were "impossible." Eventually the tool maker made three tools of his own, which he was certain would accomplish all that the Taylor-White tools did, and together they made another trip to Bethlehem. Mr. Dodge described amid much merriment the trials of these tools in competition with the Taylor-White tools; the result being of course the immediate failure of his tools.

Eventually he obtained a license for the use of the Taylor-White steel and began operations with it, but not at first with much success. He was surprised to learn from Mr. Taylor that the tools which he had seen perform such remarkable duty when cutting nickel-steel armor plate were entirely unsuited to cast iron, and an expensive series of experiments began in order to obtain steel for use with this material. These experiments led to an expenditure of several thousand dollars, the result of which was a single lathe equipped with a few tools for work on cast iron, and he began to see the far-reaching significance of this steel, and the fact that it involved a large outlay in reorganizing the works began to impress itself upon him.

As a final result he explained that, whereas their works had formerly consumed 50 horse-power, they now consume 160.

As an illustration of the far-reaching effects of the tools of the new steel, he referred to its effect on the prices for piece work. With the output greatly increased, the danger of setting an excessively high piece price was very greatly increased, and he soon saw that their old methods of guessing at the piece prices would not answer.

Consulting Mr. Taylor, he was told that the only way out of this difficulty was the introduction of a scientific rate-setting department, and, beginning with this, reorganization of every department of the works was ultimately called for.

The greatest difficulty which has been found in connection with the introduction of the Taylor system has been found to lie in the acquiring of the necessary mental attitude on the part of all concerned in the work; and, as a matter of fact, it had required two years' time to bring those in charge of the works to a point where they capitulated to Mr. Taylor's ideas. Another great difficulty lay in the desire of everybody to improve on Mr. Taylor's methods, and along with this came the feeling of the head of every department that while the new methods were well adapted to other departments, they were not adapted to his.

He regarded high-speed steel as the direct cause of the now wide-spread movement toward the reorganization of industrial methods. The effective use of this steel requires a far better degree of organization than that previously existing and the steel has directed attention to the entire subject of industrial organization and has led to a wide-spread awakening regarding the importance of this subject.

Referring to the system itself, he explained that its underlying principles lie in task setting, time study and explicit directions to every workman, and to illustrate its thorough-going character he said that he would be entirely satisfied if, at the end of two years, they had succeeded in finding two men who could stand a rigid examination regarding all the details of the system as applied at the works of the Link Belt Engineering Company. He said, as a matter of fact, that he did not believe Mr. Taylor himself could stand such an examination.

Referring to the new branch of engineering—production engineering—he said that he regarded it as plain that the necessary study for the improvement of the methods of a manufacturing plant could be best made by an outsider. If a given concern is prosperous, the management is too busy with its regular duties to undertake general reorganization, while if times are dull the disposition is to let such things alone. He could give much statistical information regarding the increased output obtained, but did not think it advisable to do so. As a matter of fact, he regarded the changed mental attitude of the entire force to be quite as important as this. The system does not set a killing pace for anyone, but conserves his energy and directs his efforts to a single purpose. Each workman finds his work conveniently placed without thought on his part, and he finds explicit directions for every operation. The tools are brought to his hands and the finished work removed by others. His efficiency is increased without injury to himself.

The discussion was extremely animated and consisted chiefly in a series of questions and replies thereto by Mr. Taylor, who captivated his audience, as he always does when talking on this subject. One of these questions related to the minimum size of a works to which the system is adapted. In reply to this question Mr. Taylor said that he had recently installed the system in a works in Philadelphia employing 120 men, the work of the shop being of a very varied character, and for conditions of this kind he regarded this number of men as about the lower limit. Under the old system the shops turned out about $10,000 worth of work a month, and this was about its limit, as the tools were all well occupied. During the past three months this shop has turned out an average of $25,000 worth of work a month. The pay-roll is about $300 a week less than formerly, but against this come the expenses of the planning room, which, added to the regular pay-roll, make the total weekly outgo larger than formerly. It is the expense of the planning room which limits the application of the system to small shops. Of course, no rule can be given. When the work is simple the organization is simple, and vice versa; but for work of the character done in the shop referred to, he considers 120 men to be about the lower limit. He explained that there are at the present moment several new types of machines in progress at these works, and as a result of the application of the system the first machines of these new types are made by piece-work, the same as the old machines have been.

As an illustration of his system he described the difference between an order as commonly given and an order as given under this system. Under the usual method, an order is general and the workman takes it expecting to do better than he is ordered to do, if possible; whereas under the Taylor system he is not allowed to do any better, but is required to do exactly what he is told; and the chief difficulty in the installation of the system is to get workmen to understand that they must absolutely obey orders and not to make any improvements on them. If they see an opportunity for improvement, they are expected to report it to the regular improvement channel, and if approved it will be ultimately adopted as the regular method; but, so far as the order in hand is concerned, it must be obeyed implicitly. In this way any improvement which is found to be real, finds ultimately a much wider application than under the old plan and full benefit is obtained from it.

Asked if there were serious difficulties in introducing the system in union shops, Mr. Taylor said not if the matter was handled in the right way. The shop referred to above was thoroughly unionized when its reorganization began, and while they had had visits from union officials, they had had no trouble, because they had done nothing to which the union could object. For example: A man was never told that he must do more work. On a lathe job, for example, he would be told to increase the feed and speed and depth of cut to certain figures, but nothing was said about the increased output, which was entirely incidental. No one could object to an order to take a wider cut, and by adhering to this principle no difficulties had been encountered.

Perpetual Motion at Last.

I submit herewith the drawing of a working model of a perpetual motion machine. I know how other inventors who have worked along this line have been made fun of, and the fear of ridicule has for years kept me from making my invention public. In fact, I invented it while still a small boy, and I think a single glance at the drawing will show how simple both the machine and its inventor are.

PERPETUAL MOTION AT LAST.

The machine consists of a number of radial arms, to the end of each of which is attached a weight, the whole revolving on an axis. The machine revolves from right to left. As it turns, the weights attached to the ends of the arms gradually change from 6 to 9 pounds each, the transformation being reversed as the weights begin to rise. This may seem complicated—even absurd—to some; but every great invention has been laughed to scorn by the ignorant and fatuous populace. Besides, a single glance at my drawing will show that in spite of what physicists may say, the weights on my machine do act in just that way.

I am not looking for any financial reward. I shall be satisfied if no one throws a brick.—*I. N. Ventor in The Technical World.*

Recent high-pressure tests made on the experimental locomotive at Purdue University by Prof. W. F. M. Goss indicate the inadvisability of working pressures above 200 lb. At 240 lb. serious difficulties were encountered with the operation of the injectors, check valves, etc., while many parts and fittings normally tight at about 200 lb. pressure and less commenced to leak steam.—*The Engineer.*

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The Tariff War Becoming Unpopular in Germany.

We learn from Daily Consular and Trade Reports that opposition to the tariff discriminations against this country is beginning to show itself in Germany. Consul-General Guenther, of Frankfort, reports that the Sonneberg chamber of commerce includes the following in its recent report:

We must make front against those who incline toward forcible measures in shaping our trade relations with the United States. Such attempts run directly counter to the interests of Germany's industries and German exports, and if these attempts succeed it will take a long time for the Empire to get over it. Although the American prohibitive system and other hardships and unfair treatment incident to the American customs administration put us in bad humor, we must do all that is possible to arrive at an understanding in a friendly way by a decided but prudent course. A country like ours, which makes and must make most strenuous efforts to conquer foreign markets, can not seriously count upon success by adopting a rigorous course in tariff matters. Whoever advocates a tariff war forgets that the 500 million marks of goods we annually sell to the United States come into question; that the relations with our third largest customer will be interrupted for an indefinite time; that once the threads of intercourse are torn it will be a hard task to tie them together again. Finally, such a war-tariff champion overlooks the injury caused to our working population. Our tariff war with Russia in 1893 dealt our economic system severe blows. Our conflict with Canada has seriously decreased our exports to that country.

What the consequences would be to us in case our trade relations with such an immensely more important country as the United States were to be broken off we need not detail; they are self-evident.

The chamber of commerce of Sonneberg represents an important manufacturing district of Germany in the lines of toys, china and glassware, and many other articles. Of the total exportation of German toys to the United States the Sonneberg district supplied 53 per cent.

The Revival of Interest in Canals in England.

In England, as here, transportation by canals has for some time been on the decrease, whereas in continental Europe it is on the rapid increase. A consideration of this fact is leading to a revival of interest in canals in England and a re-examination of the entire subject. It appears that in England the canals are largely private property, and that they have been acquired by the railroads in their own interest, and the Associated Chambers of Commerce have passed a resolution in favor of their being bought up and worked in the public interest. Added to this comes an official and unexpected announcement of the Government to appoint a Royal Commission to inquire into the question of canal communication. One of the drawbacks of the British canals is the frequency of locks, which average one lock for every 1¼ miles of navigation in the entire canal system of England and Wales.

The question of the power propulsion of canal boats is also receiving a good deal of attention and experiments have been begun to test the practicability of applying gas-motor engines to the propulsion of barges, the generation of the gas being by gas producers. A motor of this description and for this purpose has been worked out by the Thornycroft Company, for which great claims are made.

There is a very inadequate idea in this country of the extensive development of canals in continental Europe. In Belgium, for example, the kilometric tonnage increased from 852,137,000 in 1901 to 1,035,422,000 in 1903, the total expenditure of the state in maintaining the canals being $4,144,485. In France the kilometric tonnage in 1903 was 4,955,000,000 and over $41,000,000 is now being spent on the construction of new and the improvement of old canals in France. Great developments are also taking place in Germany, where a sum of over $83,000,000 is to be spent in this direction.

French Locomotives in England.

Our readers are well aware that the DeGlehn design of compound locomotive has shown performances which are attracting wide attention among railroad men. We have several times referred to the purchase of one of these locomotives by the Pennsylvania Railroad for testing at the St. Louis exhibition, and subsequently for service trial upon the road, and a still more striking example of the wide influence of this design is found in the importation of four engines of this type for service trial in Great Britain. Two of these made their appearance on the Great Western Railway last summer, and the experience with these has been so satisfactory that two more have recently been imported. They are of unusual size for Great Britain, having a total heating surface of 2755 square feet, which, with a single exception, exceeds anything in Great Britain.

The engines are of the construction which is identified with the name of De Glehn, which comprises four cylinders, two of which are high pressure and external to the frames, while the other two are low pressure and between the frames—the external cylinders connecting with crank pins on the driving wheels, and the internal cylinders connecting to cranked axles.

They run between Paddington and Plymouth, England, and are employed on the fastest and heaviest main-line expresses. They make a run of 245¾ miles without an intermediate stop, which is stated to be the longest non-stopping run in the world. The run is made in 4 hours and 25 minutes for the down journey, and 4 hours and 25 minutes for the up, the total load behind the engine being 220 tons, and the average speed 55 3/10 miles per hour from start to stop. The run has several steep grades, one being as high as one in forty; although, because of its length, 2¼ miles, a grade of one in forty-two is considered the worst on the line. In spite of these grades the engines have driving wheels of 6 ft. 8½ in. diamter. and according to all accounts their performance has been eminently satisfactory, although we have seen nothing regarding their economy as compared with British-built engines.

New Publications.

"The Wiring Hand-book." By Cecil P. Poole. 85 4½ by 8 inch pages, with 61 illustrations and 32 inset tables. The McGraw Publishing Company, New York. Price, $1.

This is a very compact and useful handbook devoted exclusively to wiring buildings for lamps and electric motors. It gives by diagrams the names of the various parts of a circuit, and then in successive chapters discusses the determination of wire sizes, wiring for three-wire circuit, direct-current motor wiring, alternating-current wiring, determining the size of bus-bar conductors, circuit connections and, in an appendix, gives a digest of the underwriter's rules applying to inside wiring. The tables, which are numerous and extremely useful, have been printed on folded sheets of tough paper, in order that they may be spread out conveniently when in actual use, without reference to the text of the book. The language is very simple and plain, with no unnecessary mathematics. Those who have to do with the wiring of buildings for lamps or motors will find the book an extremely useful manual.

"Standard Telephone Wiring." By James F. Fairman. 91 4½ by 7 inch pages, with 74 illustrations. The McGraw Publishing Company, New York. Price, $1.

The scope of this book is sufficienty indicated by its title. It begins by describing the various classes of telephone apparatus, and then proceeds to take up the subjects of installation, common battery, and magneto systems, concluding with a chapter on telephone troubles, and the rules of the National Board of Fire Underwriters, so far as they apply to the subjects discussed in the book. The book is compact, convenient and admirable in every way.

New Tools and Machine Shop Appliances

MULTIPLE SPINDLE DRILL.

A new manufacturers' drill is shown by the three illustrations herewith. Fig. 1 shows the No. 4 bed with four top columns and spindles, Fig. 2 the same thing with two of the spindles removed, and Fig. 3 is a detail illustrating the method of tightening the driving chain, the drive in this machine being positive, by means of gears and Whitney silent chains. The speed changes, of which there are three, are made for each column independently of the others by means of a sliding gear within the box at the back of the column (see *A*, Fig. 2), which can be placed at the idle notch when it is not desired to use the spindle in question. The machine is adapted for jig work, the top columns being adjustable for different distances center to center of spindles. The distance from the face of the top column to center of spindle is 7 inches. The vertical adjustment of the table is accomplished by a rack and pinion, the greatest distance from the table to spindle being 33 inches. The traverse of the spindle is 10 inches and the length of feed 4⅜ inches, the feed being by hand levers. The spindles have either No. 1 or No. 2 Morse tapers. The adjustment of the driving chain is accomplished as follows: *A*, Fig. 3, is the vertical shaft which passes up through the top column and which carries on its upper end a disk *B* provided with slots, into which project pins or studs *C*, which are carried in the hub of the sprocket wheel *D*, running upon the bushing *E*. As the outside of *E* is eccentric to the shaft *A*, it follows that turning *E* will vary the distance of the center of the sprocket wheel *D* from the center of the sprocket wheel on the drill spindle. The set-screw *F* holds *E* in any position given it. The slots in *B* allow the pins to approach to and recede from the center of the shaft *A* as the shaft and wheel revolve.

The bearings are bushed with phosphor-bronze and can be replaced in case of wear without losing the original alinement. The thrust bearing of each spindle is a ball bearing. The table for the No. 4 machine is 15x34 inches and the weight of the machine is 900 pounds. It is stated that the machine will drill ½-inch holes 1 inch deep in cast iron in 8 seconds, and ¾-inch holes

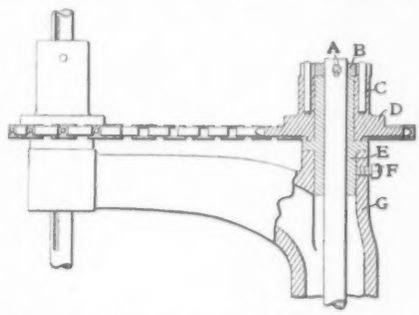


FIG. 3. SHOWING METHOD OF TAKING UP SLACK IN DRIVING CHAIN OF DRILL.

of the same depth in 18 seconds. This drill is built with from one to six spindles by the Fenn-Sadler Machine Co., Hartford, Conn.

46 IN. X 14 IN. X 20 IN. PLAIN MILLING MACHINE WITH ALL-GEAR FEED.

This machine has a positive gear-feed drive and change-feed mechanism, by which twenty changes of feed can be made without stopping the machine. It has also a new clutch mechanism in connection with the hand wheels, a knee of

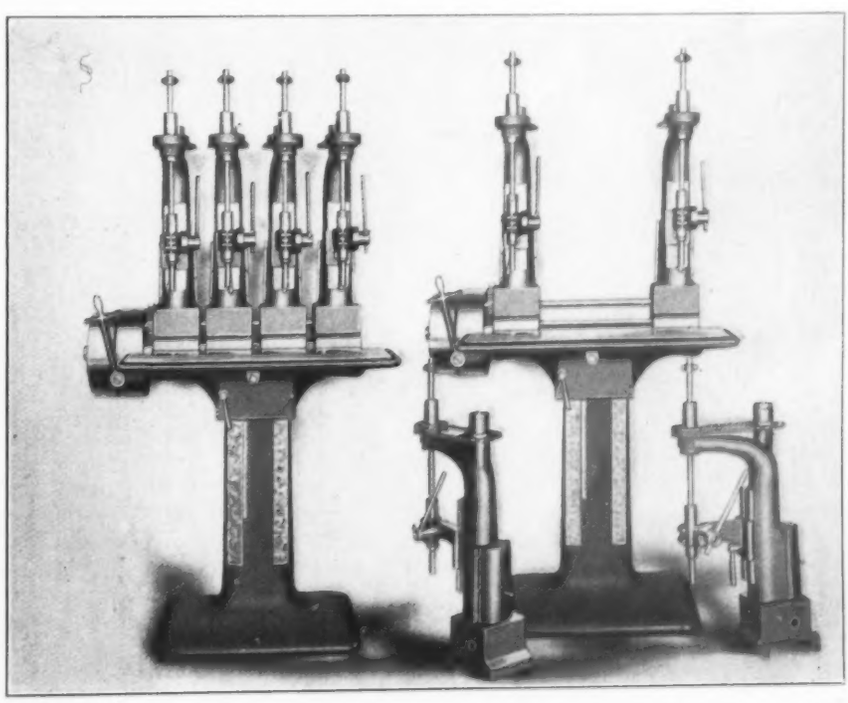


FIG. 1. NO. 4 MANUFACTURERS' DRILL. FIG. 2. DRILL WITH TWO SPINDLES REMOVED.

box type and a telescopic elevating screw. The change-feed mechanism is located at the back of the column, and by means of a simple movement of one lever the twenty changes are instantly obtained. The clutch arrangement for the hand wheels is enclosed in the hubs of the wheels. When the table has been set to required position, the clutch may be instantly disengaged by pressing in the knob on the front of the hand wheels, thereby preventing any accidental change from their fixed position, and also preventing them from revolving when the automatic feeds are thrown in. The range of the table feed is 46 inches, of the cross-feed, 14 inches, and the vertical movement of the knee 20 inches. These are all effected by power. The driving cone has three steps, for 3½-inch belt, and the spindle has 18 speeds, varying from 18 to to 220 revolutions. The machine is the No. 4 plain miller of the Becker-Brainard Milling Machine Company, Hyde Park, Mass.

TEST INDICATOR.

The engravings illustrate a new instrument designed for testing the alinement of centers, the truth of face plates, for setting work accurately in the miller and under drill spindles, and for many other purposes which will suggest themselves to the tool maker. The construction of the tool

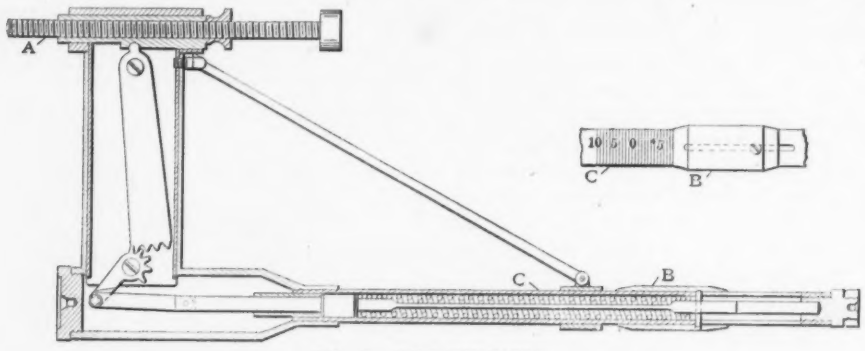


FIG. 1. TEST INDICATOR.

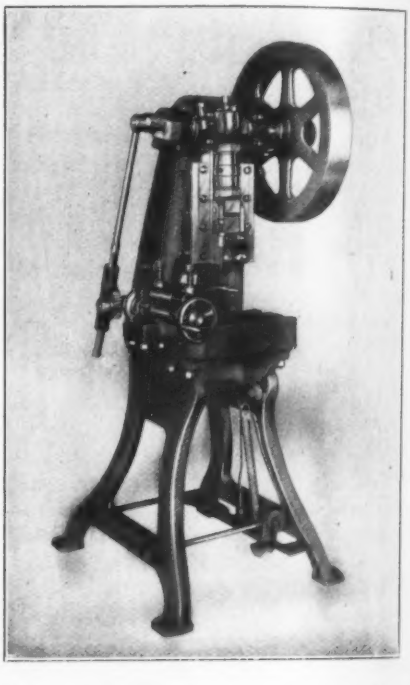
is brought out quite clearly in the line engraving, and very little is needed in the way of an explanation. It will be observed that the contact screw *A* is so connected to the sleeve *B*, which slides on graduated tube *C*, that any end movement of *A* due to absence of alinement or truth in parts being tested, will produce a much greater sliding movement in sleeve *B*. The latter will of course remain free from reciprocating motion only when the center, face-plate or whatever is undergoing inspection is dead true. The tube is graduated to read in thousandths, and errors may be noted with the instrument revolving. When desired to rotate the tool in the miller or under a drill spindle, as when setting a piece of work central with the latter, provision is made for driving by means of a special center with an arm attached, which center is held in the chuck while the outer end of the arm engages the contact screw *A*. The inventor of this tool is Adolph F. Henrikson, Troy, N. Y.

SPECIAL SINGLE ROLL FEED FOR "BLISS" POWER PRESS.

Roll feeds are made in great variety to suit special requirements. Of all of the numerous types, three are the most widely used; the first of these is a friction disk roll feed; in this feed the pawl operates on the edge of a toothless disk, taking its bite by means of a wedging action, which permits of easy adjustment and fine spacing. This feed is largely used for clock and watch parts, Yale key blanks and many similar articles.

The second type of roll feed is that driven by a pawl and ratchet. This feed is perhaps the best known and most widely used, but it has its limitations, as it will feed only to about five-eighths of the diameter of the rolls, the variations being from nothing to a maximum by a division in proportion to the number of teeth cut in the ratchet wheel. A very fine adjustment of feed necessitates a rachet wheel with very fine teeth or three or four pawls, and to feed any great length makes it necessary to have the rolls of comparatively large diameter, or else to back-gear them.

The illustration herewith shows a rack roll feed designed to accommodate cases to which the pawl and ratchet feed is not well suited. The construction of this feed is very simple, and its method of operation will be readily understood by examining



PRESS WITH SPECIAL SINGLE ROLL FEED.

the illustration. The feed rolls are driven by a rack which is part of the connecting rod which is adjustable in a crank block on the shaft end by means of a set-screw. The greater the distance of the connecting nut from the shaft center, the greater the travel of the feed, and this distance can be made to take in practically anything. A very fine feed can be made, or with more adjustment, feed to take the largest kind of work without materially increasing the size of rolls. If the nature of the work demands, it is possible to build a double roll feed of the same general construction.

This feed is shown as applied to one of the presses of the E. W. Bliss Company, of Brooklyn, N. Y.

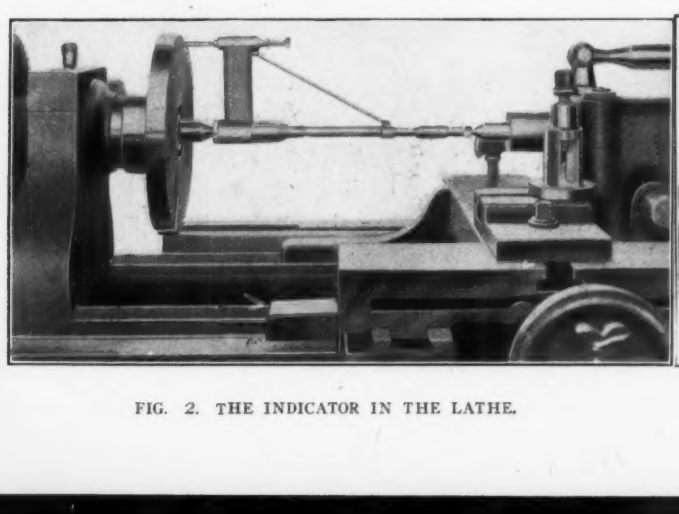


FIG. 2. THE INDICATOR IN THE LATHE.

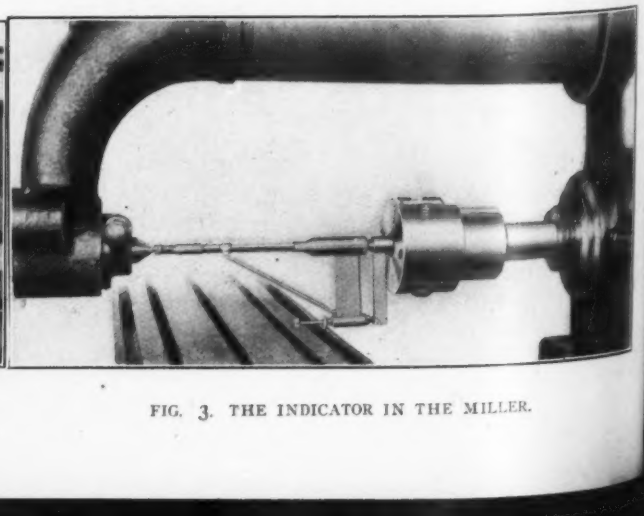


FIG. 3. THE INDICATOR IN THE MILLER.

The St. Louis Locomotive Tests.

By the courtesy of the Pennsylvania Railroad we are in receipt of the report on the locomotive tests conducted by it at the St. Louis world's fair.* The book is a worthy record of a great enterprise, comprising as it does 734 6x9-inch pages with over 800 illustrations. The book is finely printed on thin, high quality paper, and the quality of the engravings and of the binding is in keeping with the contents and the other mechanical features.

We published at page 1661, Vol. 27, an article on the dynamometer which forms part of the testing plant, and a still more complete description of it and of the entire outfit will be found in this volume.

The book contains full drawings and descriptions of the locomotives tested, of which there were eight, together with the data accumulated, which latter include many tables and a wealth of diagrams from the recording apparatus.

Among the engines tested were the De Glehn, which had been imported from France by the Pennsylvania Railroad, and an engine by the Hannoversche Maschinen Actien-Gesellschaft of Hannover, Germany, which formed an exhibit at the exposition. Both the foreign engines had the Walschaert valve gear, and the boiler of the French engine was fitted with Serve tubes. The German engine was fitted with a superheater, and both had copper fire-boxes.

No.	Freight Locomotive.	40 R. P. M.	80 R. P. M.	160 R. P. M.
585	[Schenectady Compound]	1.00	1.00	1.00
929	[Baldwin Tandem Compound]	1.23	1.15	....
499	[P. R. R. Simple]	1.38	1.25	1.06
734	[L. S. & M. S. Ry., Simple]	1.40	1.27	1.07

TABLE 1. RELATIVE STEAM CONSUMPTION OF FREIGHT LOCOMOTIVES.

No.	Passenger Locomotive.	80 R. P. M.	160 R. P. M.	240 R. P. M.	280 R. P. M.
2312	[De Glehn 4 Cylinder Balanced Compound]	1.11	1.17	1.26	1.27
595	[Vauclain 4 Cylinder Balanced Compound]	1.22	1.13	1.16	.97
628*	German 4 Cylinder Balanced Compound	1.00	1.00	1.00	1.00
628†	With Superheater]	1.07	1.07	1.06	1.07
3000	[Cole 4 Cylinder Balanced Compound]	1.15	1.17	1.28	1.04

*Superheated Steam. †Saturated steam, calculated.

TABLE 2. RELATIVE STEAM CONSUMPTION OF COMPOUND PASSENGER LOCOMOTIVES.

GENERAL RESULTS OF THE TESTS.

The book contains a summary of conclusions and from these we make a few extracts. The most striking of these conclusions is the fact that the locomotive, both in its boiler and its engine, compares favorably in economy with stationary engines. As the report puts it, "A study of the data showing the steam consumption per indicated horse-power-hour as well as steam and coal per dynamometer horse-power-hour, indicates that the performance of the steam locomotive is far better than is commonly supposed, and that the economy compares favorably with other methods of traction;" and again, "It is a fact of more than ordinary significance that a steam locomotive is capable of delivering a horse power at the draw bar upon a consumption of but a trifle more than two pounds of coal per hour. This fact gives the locomotive high rank as a steam power plant." Of the boiler it is said that "It compares favorably in efficiency with good stationary practice while capable of developing large overload horse-power for emergencies at a sacrifice of economy."

Revolutions.	Maximum.	Minimum.
40	94.06	76.74
80	94.16	79.46
160	93.95	72.89
240	90.20	72.27
280	86.83	61.53
320	78.27	78.27

TABLE 3. MACHINE EFFICIENCIES.

Of actual figures we find the statement that the normal action of locomotive boilers involves "the delivery of approximately 12 pounds of steam per foot of fire-heating surface per hour, and in one case as much as 16 pounds; that whereas in stationary practice it is customary to allow about 10 feet of heating surface per boiler horse-power, in these locomotives between two and three feet only were required. The economy also was good in a number of tests, the equivalent evaporation per pound of coal being 12 pounds and in only a few cases as low as 6 pounds." Of the copper fire-boxes it is said that "no advantage either in economy or capacity can be traced to this cause;" and of the Serve tube we are told that its "value over the plain tube of the same outside diameter, either as a means for increasing capacity or efficiency, was not definitely determined." Of the engines we are told that "the results show that the modern simple freight locomotive of the types tested can be depended upon to develop continuously from 1000 to 1100 horse-power. The limit of power under constant conditions of running for the modern compound passenger locomotive may exceed 1600 horse-power. Particularly significant is the high economy which attends the action of the simple locomotive over a wide range of action; for all speeds and cut-offs commonly employed upon the road the variation in cylinder performance falling between the limits of 23.4 and 28.3 pounds of water per indicated horse-power-hour. The compound locomotives tested when running under all speeds and cut-offs gave an indicated horse-power-hour in return for the consumption of from 18.6 to 27 pounds of steam; with the superheater locomotive No. 623 [the German locomotive], the minimum consumption was reduced to 16.6 pounds of superheated steam per hour.

"At all speeds the engine of the cross compound locomotive No. 585 [a Schenectady two-cylinder compound] were the most economical, although the advantage of the compound decreased with increase of speed. By averaging the steam consumption for each locomotive at each speed we obtain Table 1, the consumption for engine No. 585 being taken as unity. This table shows that at the higher speeds the advantage of the compound is very small; in fact there would be no difference at about 200 revolutions per minute. In general the steam consumption of the simple engine decreased with increase of speed, while that of the compounds increased, which would lead to the conclusion that the steam distribution of the compounds was less satisfactory at high speed than that of the simple locomotives.

[Passenger] "Locomotive No. 628 [the German engine], which in all cases gave the best performance, used superheated steam; the steam consumption increased very rapidly as the power developed increased. Averaging the consumption at each speed and taking No. 628 as unity, we have the figures of Table 2.

"Throttling tests were made only on the first three locomotives, and while the steam was slightly superheated by wire drawing, any considerable amount of throttling did not prove as economical as running with open throttle and shorter cut-off. Very small throttling had no appreciable effect.

"Eliminating tests in which the machine friction was apparently abnormally high, Table 3 gives maximum and minimum values of machine efficiency for each number of revolutions."

GENERAL CONCLUSIONS.

Of general conclusions we extract the following:

"The quality of steam delivered by boilers of locomotives under constant conditions of operation is high, varying somewhat with different locomotives and with changes in the amount of power developed, between the limits of 98.3 and 99 per cent.

"The evaporative efficiency is generally maximum when the power delivered is least. Under conditions of maximum efficiency most of the boilers tested evaporated between 10 and 12 pounds of water per pound of dry coal. The efficiency falls as the rate of evaporation increases. When the power developed is greatest its value commonly lies between limits of 6 and 8 pounds of water per pound of dry coal.

"The loss of heat through imperfect combustion is in most cases small, except as represented by the discharge

*Copies of the book may be obtained of D. T. Newball, Purchasing Agent Pennsylvania Railroad, Broad Street Station, Philadelphia, Pa. The price is $5.

from the stack of solid particles of fuel.

"The steam consumption per indicated horse-power-hour necessarily depends upon the conditions of speed and cut-off. For the simple freight locomotives tested, the average minimum is 23.7. The consumption when developing maximum power is 23.8, and when under those conditions which proved to be least efficient, 29.

"The compound locomotives tested using saturated steam, consumed from 18.6 to 27 pounds of steam per indicated horse-power-hour. Aided by a superheater the minimum consumption is reduced to 16.6 pounds of superheated steam per hour.

"The loss of power between the cylinders and the drawbar is greatly affected by the character of the lubricant. It appears from the test that the substitution of grease for oil upon axles and crank pins increases the machine friction from 75 to 100 per cent.

"The coal consumption per dynamometer horse-power-hour for the simple freight locomotives tested is, at low speed, not less than 3.5 nor more than 4.5 pounds. the value varying with running conditions At the highest speeds covered by the tests the coal consumption for the simple locomotives increased to more than 5 pounds

"The coal consumption per dynamometer horse-power-hour for the compound freight locomotives tested is, for low speeds, between 2 and 3.7 pounds. Results at higher speeds were obtained only from a two-cylinder compound. the efficiency of which under all conditions is shown to be very high. The coal consumption per dynamometer horse-power-hour for this locomotive at the higher speeds increases from 3.2 to 3.6 pounds

"The coal consumption per dynamometer horse-power-hour for the four compound passenger locomotives tested, varied from 2.2 to more than 5 pounds per hour, depending upon the running conditions. In the case of all these locomotives the consumption increases rapidly as the speed is increased.

"A comparison of the performance of the compound freight locomotives with that of the simple freight locomotives is very favorable to the compounds. For a given amount of power at the drawbar, the poorest compound shows a saving ir coal over the best simple which will average above 10 per cent., while the best compound shows a saving over the poorest simple which is not far from 40 per cent. It should be remembered, however, that the conditions of the tests, which provided for the continuous operation of the locomotives at constant speed and load throughout the period covered by the observations, are all favorable to the compound.

"With the testing plant in its permanent location at Altoona, it is proposed to continue the work begun at St. Louis and tc make further investigations of locomotive performances. The tests already made have suggested lines along which it would be profitable to continue further experimental work."

The service performed by the Pennsylvania Railroad in organizing and carrying on these tests and in publishing the results of them can scarcely be too highly commended. It is admirable in every way.

Lubrication and Temperature of Bearings.*

BY A. M. MATTICE.

I will confine my remarks to a few practical observations, principally on the matters of lubrication and temperature.

In a great many cases bearings give trouble although the surface velocity and pressure per unit area are well within safe limits, the troubles being caused by the lack of attention to small but essential details.

One of the commonest causes of trouble in two-part bearings is side binding. This occurs principally in vertical engines and in other machinery where the principal load on the bearing is that due to the dead weight of the rotating part. The bearing boxes are too often bored and scraped to a good fit all around without being eased off to prevent wedging action near the parting of the boxes. This not only causes a tremendous pressure on the bearings at these points, but prevents the oil getting in between the shaft and the bearings. A bearing is always much better if eased off so that it will be well clear of the shaft for at least 20 degrees of arc on each side of the center line, and even 30 degrees is not excessive. Many designers, especially those who have not had practical experience in the operation of machinery, seem to dislike to lose any part of the bearing area by easing off the sides of the boxes, but area at these points is more detrimental than efficient, and bearings which are originally made with all around contact can frequently be improved by the use of hammer and chisel.

Give the oil a fair chance to get in its work. The edges of bearing boxes are frequently left sharp, thus scraping off the oil instead of assisting it to enter. If the box is eased off to form a channel for the oil, meeting the shaft approximately on a tangent, oil will be drawn in instead of being scraped off.

OIL GROOVES.

In the matter of oil grooves also, designers frequently seem loth to sacrifice bearing area, apparently losing sight of the fact that no area, no matter how great, can be sufficient unless properly lubricated. Oil grooves should be large, arranged so as to keep the oil well distributed, and should have the edges well rounded off to faciliate the entrance of oil between bearing and journal. The simple removal of the sharp edge of the groove is not sufficient. Too many designers, moreover, seem to look upon the matter of oil grooves as of too little importance to be worthy of their consideration, but rather something to be left to the shop to take care of, or to be neglected entirely. The result frequently is an oil grooving which does more harm than good, leading the oil to certain parts of the bearing and leaving other parts dry.

FLOODED LUBRICATION.

From time to time various systems of improved lubrication have appeared, such as ring oiling, chain oiling, felt pads, packed waste, compression and spring grease cups, etc. But with the exception of the "splasher" system, which is very efficiently used in a number of types of enclosed engines, the old type of drop-by-drop lubrication, feeding the oil in homeopathic doses is the one most generally used with engines, although it is about the least efficient and most expensive method of all. It is not only a wasteful method, but leads to danger of cutting bearings by reducing the oil supply to a dangerous minimum. It is not altogether the fault of engine builders that this form of lubrication is the one most generally used by them, but rather because purchasers will not stand the slight additional first cost of a better method.

Ring oiling and kindred systems are very efficient for a large class of bearings, but unfortunately are not well adapted to engine work, especially in large sizes, although some designers have done some very good work along this line.

Grease and similar lubricants have their limitations, but are ideal lubricants for many purposes, and in engine work can be used to good advantage on the smaller parts of valve gear and even on eccentrics.

Supplying oil under pressure is a necessity with step bearings which carry very heavy weights, and has been applied with success to horizontal bearings where the work is extremely heavy; but this class of lubrication may be considered as adaptable only to special cases where it is an absolute necessity, to be avoided if possible.

The central gravity system of lubrication which has come into extensive use in engine installations within the past few years has resulted in a marked saving in cost of lubrication and the elimination of bearing troubles, and the details of such systems are well worth the serious attention of engineers. I refer to the systems which, while varying in details, comprise essentially an overhead supply tank, pipes leading to all bearings with valves for regulating the supply, arrangements for catching the overflow oil, settling tanks, filters and pumps for returning the oil to the supply tank, the whole system being automatic, and resulting in a continuous circulation of oil. Although this

*Contributed to the discussion on bearings at the New York meeting of the American Society of Mechanical Engineers.

system is at present used principally in large installations, it has been used with success in smaller plants, and I believe that engineers would be fully justified in using it in installations of single engines of large or even moderate size. Its success is not only due to the saving of labor, as in large installations, but by supplying an excess of oil to the bearings the oil does not become "worn out," as in the drop-by-drop system, resulting in a reduction of oil bills.

A further extension of the principle of continuous circulation of oil obtains in the flooded system of lubrication which has come into use in connection with steam turbines. In fact, this system was introduced by Parsons before the central gravity system for reciprocating engines came into vogue. This system consists in supplying to the bearings as much oil as will flow through them; the oil carrying away the heat of the bearings and being cooled in a tubular cooler before going back to the bearings again. The oil is not forced into the bearings under pressure, but simply supplied at a head of from a few inches to several feet; just enough to allow it to flow freely to the bearings. As the oil is nowhere exposed to the outside air, circulating only in a closed system, it collects no dirt and does not need to be filtered, but is used over and over again continuously, the entire oil supply circulating through the bearings every few minutes.

ECONOMY OF OIL.

By means of this system speeds and pressures are used which would otherwise be impossible, and, what is of still greater interest to the owner, is that the oil consumption is reduced to a minimum. As instances of this I would cite the cases of two installations of 400-kw. steam turbines of the Parsons type running at 3600 revolutions per minute, one of which used only 50 gallons of oil in six months and the other one 55 gallons. At another plant one turbine of 400-kw. and another of 750-kw. used only three barrels of oil in sixteen months. In another case two 100-kw. turbines used one-half gallon of oil per turbine week.

I crossed the Atlantic last summer in the turbine steamer "Virginian," and upon investigating the consumption of oil I found that no oil had been added to the tanks for four successive round trips between Liverpool and Montreal, and the supply had not appreciably diminished. The service tank had a total capacity of 293 U. S. gallons, but only 144 gallons of oil had been put in, and this was being circulated through the bearings at the rate of from 40 to 50 gallons per minute, the whole supply being circulated in less than every four minutes.

The turbine steamer "Queen Alexandra," which in the summer season makes daily trips on the Clyde, used less than one barrel of oil during a season of between four and five months.

The oil consumptions of turbine steamers above quoted are for the bearings of the turbines proper, each steamer having three turbines. The line-shaft bearings have ordinary lubrication, but I have no doubt that before long it will become the practice to use on such bearings the same system of flooded lubrication as on the bearings of the turbines themselves.

Users of engines and other machinery would do well to take a lesson from the results of steam turbine lubrication, which has demonstrated beyond a doubt that the supply of oil in large excess of that actually required to prevent bearings cutting is in the long run the most economical, and far in advance of the old drop-by-drop method.

TEMPERATURE OF BEARINGS.

Another matter upon which a few words may not be amiss is that of the temperature of bearings. There seems to be a wide misapprehension as to what is a safe temperature. I believe that much of the idea about safe temperatures is an inheritance from the time when lubricating oils were all of animal or vegetable origin and is not applicable to the high test mineral oils of today.

Some time ago I happened to get into a controversy as to proper bearing temperatures, the immediate cause of which was an engine whose main bearings ran at a temperature of about 135 degrees F., while the owner claimed that a temperature of over 100 degrees was unsafe and produced "expert" testimony to that effect. Knowing from experience that this view was not correct, but requiring testimony to the contrary, I proceeded to have examinations made of the temperature of bearings of a large number of engines of various makes. The result of this investigation showed more large engines running with bearings at temperatures over than under 135 degrees. Many bearings were running at over 150 degrees, some considerably higher, and in one case a continuous temperature of 180 degrees was found, and in all of these cases the bearings were giving no trouble.

In this connection it might be well to point out that the introduction of direct-connected electric generators has increased the temperature of engine bearings, with the same engines working under similar conditions. At first sight this may seem paradoxical, but it is easily explained. With the older types of drives the eccentrics were seldom covered, and crank oil guards, if used, were of an open type. But when driving direct-connected generators, where it is necessary to keep oil off the windings and commutators, closed oil guards are fitted over cranks and eccentrics. This not only increases the temperature of the crank pins and eccentrics by preventing a circulation of air, but also retards the radiation of heat from the main bearings as well. An additional reason is that with belt or rope drive the large wheels and the belts or ropes themselves cause a considerable circulation of air, which reduces the bearing temperature, or rather the apparent temperature, as evidenced by feeling the outside of the bearing. With direct-connected units the circulation of air is greatly reduced, with consequent temperature effect.

Personal.

Albert Ladd Colby has opened an office as consulting and inspecting engineer and iron and steel metallurgist, at 477 Central Park West, New York City.

Harry Gwinner, who has been designer with the Consolidated Gas Company, and the Chesapeake Iron Works, of Baltimore, Md., has been appointed to the chair of Mechanical Engineering in the Maryland Agricultural College, College Park, Md.

A syndicate of Mexican capitalists has called Mr. Nazel, of the Nazel Engineering and Machine Works, Philadelphia, to Mexico. Mr. Nazel will give expert advice regarding an engineering enterprise in which the Mexican Government is also interested. He will probably be away one month.

Morton H. Anderson has resigned his position of superintendent of the De La Vergne Machine Company to become superintendent of the Reliance Works of the Allis-Chalmers Company, Milwaukee, Wis. Mr. Anderson had been with the last-named company for fifteen years, previous to coming to the De La Vergne Machine Company.

George H. Baush, of Springfield, Mass., who has been vice-president and general superintendent of the Baush Machine Tool Company since its organization in 1896, has resigned his position, though still retaining his financial interest in the concern. Mr. Baush has made no plans for the future and will take a much-needed vacation before engaging in new work.

Obituary.

Henry Rustin, a well-known electrical engineer, who designed the illuminations of the World's Fair at Chicago and the expositions at Buffalo and Omaha, died recently at his home in Florence, Neb.

Jackson Richards, Sr., for 25 years master mechanic of the Philadelphia & Reading Railroad, died recently at his home in Philadelphia, Penn. He was the inventor of the Richards balance engine and other railroad appliances. He retired three years ago.

Andrew H. Hammond, president of the Hammond Reed Company of Worcester, Mass., who in early life followed the trade of iron molding but later engaged in the manufacture of organ reeds and built up one of the largest establishments

of the kind in the world, died March 1, aged 75 years.

John Milton Greist, president of the Greist Manufacturing Company of Westville, Conn., and one of the leading inventors and manufacturers of New England, died at his home in Westville, February 23, after an operation. Mr. Greist was born in Crawfordsville, Ind., and was 53 years old.

Edward Edwards, of Catasauqua, Penn., was stricken with apoplexy February 21 in his office at the Slatington Rolling Mills, of which he was president, and died during the night. Mr. Edwards was born in Wales 64 years ago, came to this country when a youth and learned iron-making under David and Samuel Thomas.

James A. Mason, assistant superintendent of the Blake & Johnson Company, Waterbury, Conn., died in that city, February 24, of Bright's disease, aged 34 years. Mr. Mason learned his trade at the Pratt & Whitney shops in Hartford and was employed at that place for about 15 years, the last four or five as a foreman. He had been located in Waterbury about two years.

Edwin Gilbert, president of the Gilbert & Bennet Manufacturing Company, of Georgetown, Conn., died March 1 at Crescent City, Fla., aged 80 years. He was born in Georgetown and had always lived there. He was one of the first to manufacture wire goods and was the inventor of machines which weave over a mile each of wire fencing in a day. After working for many years as a mechanic he became a manufacturer and thirty years ago organized the company of which he was president.

Samuel Thomas, a pioneer pig-iron manufacturer, died February 21 at his home in Catasauqua, Penn., after an illness of several months of kidney disease, aged 79 years. Mr. Thomas was born in Wales and was a son of David Thomas, who first successfully introduced in this country the anthracite blast for the manufacturer of pig iron. David Thomas and his son in 1854 organized the Thomas Iron Company, and established works at Hokendauqua, Penn. The company now operates twelve stacks in various parts of Pennsylvania.

John W. Babson, chief of the issue and gazette division of the United States Patent Office, died at his home in Washington, March 1, aged 71 years. He was born in Maine, was graduated from Maine Wesleyan College, where he afterward served as an instructor. He went to Washington in 1861 as secretary to the then Vice-President, Hannibal Hamlin, and in 1866 was transferred to the Patent Office. He served as departmentary commissioner of patents, chief of the pension division, and in charge of the official gazette, which was under his supervision up to the date of his death.

William Alfred Hovey, well known in journalistic and engineering circles, died at Boston, Mass., February 17, aged 64. Mr. Hovey for several years after the Civil war was connected with coal mining interests in Pennsylvania, as engineer and superintendent, and later removed to Chelsea, Mass., to conduct a weekly paper. In 1872 he became managing editor of the Boston *Commercial Bulletin* and in 1875 succeeded to the editorship of the *Transcript*, from which position he retired in 1881 to establish the *Manufacturers' Gazette*. Later he became president of the Merchants' Electric Light & Power Company, and then editor of the *Electrical Review* in 1884. Since 1885 he had been connected with the American Bell Telephone Company.

Samuel Pierpont Langley, secretary of the Smithsonian Institution at Washington and known throughout the world as a scientist, died after a second stroke of paralysis, February 27, at Aiken, S. C., aged 72 years. He was born in Roxbury, Mass., graduated from the Boston High School and early in life took up the practice of architecture and civil engineering. In 1865 he became an assistant in the Harvard observatory and in 1867 was appointed assistant professor of mathematics at the United States Naval Academy. The same year he was made a director of the Alleghany observatory, where he remained for twenty years. During this time he founded the system of standardization of time for railroads and invented the bolometer, a thermometer of extreme delicacy. In 1870 he began his studies in solar physics, a field in which he became a recognized authority. He was appointed secretary of the Smithsonian Institution in 1887 and later devoted much of his time to the study of aerial navigation, a field of effort which he abandoned a short time ago upon the failure of his experiments with an aeroplane propelled by a gasolene engine. Professor Langley was a prolific writer upon scientific subjects and a member of many scientific associations.

Business Items.

The Diamond Machine Co., of Providence, R. I., are opening a salesroom at 18 Dey Street, New York City, which will be in charge of H. F. Frevert. They will carry a full line of their grinding machines in stock and will be in position to make deliveries at short notice.

A new company has been incorporated at Buffalo, N. Y., to be known as the Buffalo Crucible Castings Co. It is capitalized at $150,000 and will manufacture crucible steel castings, for use in automobiles and the smaller machines. E. G. Ripple of the Buffalo Foundry Co., John L. Osgood, George Bleistein, A. W. Thorne and F. L. Bapst are the directors.

The Diehl Manufacturing Company has recently leased the entire building at 1305 Race St., Philadelphia, Pa., for use as a warehouse, and a complete stock of apparatus of all kinds will be carried. The large increase of the business of the Philadelphia office of the company has made this action necessary. The office still remains at 1217 Filbert St.

The Olds Gasolene Engine Works, Lansing, Michigan, have just announced the consolidation of their company with the American Suction Gas Producer Co., of the same city. This new company is to have a capitalization of $612,000 and is to be called the Olds Gas Power Co., the object of which is the manufacture of gas engines, gas producers and the smaller gasolene engines for various uses.

The Toledo Machine and Tool Co., of Toledo, Ohio, builders of bar and sheet metal working machinery as well as designers and builders of special machinery are experiencing a most gratifying increase of their export business and are receiving and shipping large orders to France, Germany, Belgium and Holland. A large business is also being done by this firm in Canada.

Manufacturers.

The Kellogg Iron Works of Buffalo, N. Y., will move to Hamburg N. Y.

The Iowa Ice Company, Des Moines, Iowa, will build an artificial ice plant.

The Dunkirk (N. Y.) Stone Company, is adding a boiler house and a wet kiln.

The Marshall-Wells Hardware Company, Duluth, Minn., will erect a new factory.

Joseph Bancroft & Sons, Wilmington, Del., cotton finishers, etc., will erect a new factory.

The Mexia (Texas) Light and Water Company is erecting a plant at Springfield, Tex.

The Automatic Machine Company, Bridgeport, Conn., is having an addition built to its shop.

P. Derby & Company of New York, will erect a $100,000 chair factory in Jersey City, N. J.

Fire destroyed the pant of the Willard Bag and Manufacturing Company, Wilmington, N. C.

The Portland (Ore.) General Electric Company will make extensive improvements at its plant.

The plant of the Howell's Mining Drill Company, Pymouth, Pa., will be increased in capacity.

A new foundry building is to be erected at the plant of the United States Sanitary Company at Monaca, Pa.

The Avonmore Cast Steel Company, of Uniontown Pa., has been incorporated with a capital of $150,000.

Greenlee Bros., Rockford, Ill., builders of special woodworking machinery, are planning to put up a large addition.

Plans are completed for the new power house to be erected by the Pittsfield (Mass.) Street Railroad Company.

It is reported that the Corbin Screw Company, New Britain, Conn., has in view the erection of a large plant.

The Berwind-White Coal Mining Company of Philadelphia, Pa., will erect car repair shops at East Hollidaysburg.

The New England Boiler Company has perfected plans for the erection of a new plant in New London, Conn.

The car shop of the Colorado & Southern Railroad at Denver, Colo., which burned lately will be rebuilt at once.

The Pittsburg Plate Glass Company has increased its capital stock and will erect another plant in Crystal City, Mo.

The William Powell Company, brass founders, Cincinnati, Ohio, will erect a new foundry building to cost $40,000.

Joseph Z. Collins, carriage builder, Camden, N. J., will erect a new building, equipped with steam heating and electric power.

The Kokomo (Ind.) plant of the Kokomo, Marion and Western Traction Company will be enlarged.

The city of Manitowoc, Wis., is considering a site for the proposed new municipal water works.

The factory of the J. L. Thompson Manufacturing Company, rivets, etc., Waltham, Mass., is being enlarged.

Work has been commenced on a new factory for the Hersey Manufacturing Company, Boston, Mass., making water meters, etc.

R. E. T. Pringle & Co., Ltd., Montreal, Canada, will build a new $30,000 electrical factory to be equipped with the latest machinery.

The plant of the Bellefontaine (Ohio) Bridge & Iron Company, destroyed by fire recently is to be rebuilt immediately on a larger scale.

The Utah Packing Company, Salt Lake City, has been reorganized and will put up a large plant. George C. Whitmore of Nephi, Utah, is president.

The electric power house for the terminal station of the Pennsylvania, New York and Long Island Railroad tunnel in New York, will cost $300,000.

The plant of the Northwestern Manufacturing Company, burned sometime ago, is to be rebuilt. The company manufactures wagons and chairs.

The Standard Knitting Mills, Knoxville, Tenn., will spend about $100,000 in improvements, which will include a new engine house, boiler house, yarn mill.

Plans have been completed for an addition to the present factory and a new factory for the E. A. Bliss Company, Meriden, Conn., manufacturing novelties.

Catalog Notices.

The Means Foundry & Machine Co., Steubenville, Ohio. Catalog of brass and bronze castings. Illustrated, 5½x8½, pp. 9, paper.

A. W. Harris Oil Company, Providence, R. I. Attractive booklet entitled "Petroleum Lubricating Oils" which describes the various oils made by this company. Illustrated, 4x8, pp. 32, paper.

Ingersoll-Rand Co., 11 Broadway, New York. Catalog No. 45, describing Ingersoll-Sergeant rock drills for mining, tunneling, quarrying, and general rock excavation. Illustrated, 6x9, pp. 96, paper.

Termaat & Monahan Co., Oshkosh, Wis. Catalog describing gasolene marine engines. Tables of sizes and weights and price lists are given, as well as line drawings showing principal dimensions. 5½x7½, pp. 40, paper.

American Locomotive Co., New York. Pamphlet entitled "Four-Cylinder Balanced Compound Locomotives," which is a reprint of a paper by F. J. Cole read before the Railway Club of Pittsburg. Illustrated, 6x9, pp. 32, paper.

The Vauxhall and West-Hydraulic Engineering Co., Ltd., 23 College Hill, London, E. C. Catalog of hydraulic and arsenal machinery. This is a very comprehensive book, printed on fine coated paper and containing numerous half-tone illustrations. 8½x11, pp. 189, cloth.

Hyatt Roller Bearing Co., Harrison, N. J. Bulletin No. 28. This gives a resume of the advantages and applications of the Hyatt bearing, and shows a number of applications which have been commercially made of these bearings under various conditions. List of users, tables of dimensions, line and half-tone engravings, are also given. Copy of the bulletin will be sent to anyone interested on application. 6½x8½, pp. 46, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Pressure Blower, capacity about same as Root's No. 5. Address Brown, P. O. Drawer 6, New Haven, Conn.

Mechanical draftsman (locomotive) going to Germany 3 months, desires to represent some concern. Box 254, AMER. MACH.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia.

Work Wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

Any kind development work, special automatic machines, gas engines, automobiles, etc., designed. H. P. Moorees, M. E., E. E., 7 East 42nd st., New York City.

Wanted, at once, a 36-inch lathe, screw-cutting attachments, short bed. Must be in condition to turn out perfect work. Address X, 257, AMERICAN MACHINIST, stating full particulars.

Well-known firm desires for Germany the sole agency for plain and universal Internal Grinding Machines 12 inches by 40 inches between centers, as well as for other modern machinery, viz., Automatic Screw Machines, etc. Address H. 3. 12377, care Haasenstein & Vogler A. G., Hamburg, Germany.

Wanted—For large manufacturing concern in Illinois, first-class up-to-date man as foreman of machine shop, large department, fairly heavy work. Also a foreman of small blacksmith shop who would be willing to run a fire himself when necessary. Engineering Agency, Monadnock Block, Chicago.

Draftsmen—Experienced detailers and designers on electrical and mechanical work—gas and steam engines jigs, dies and tools, pumping machinery, transformers, motors, generators, etc.: $65—$130; over 100 positions open. Write for Vacancy List, Engineering Agency, Inc., Diamond Bank Bldg., Pittsburg, Pa.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—1000 Steam and Water gauges at $1 each. Send for list to J. L. Lucas, 2 Fox st., Bridgeport, Conn.

Foundry machine and boiler plant. $14,000. $6,000 will buy it. A rare chance. Address F. Palfrey, Macon, Mo.

For Rent—Small factory at Plainfield; gasolene engine, railroad siding; $25 per month. A. J. Brunson, Painfield, N. J.

For Sale—Gas engine business with engines from two to sixty horse power capacity. Stock of finished and unfinished engines and patterns, drawings, etc. Will sell at a bargain. Apply Box 55, AMERICAN MACHINIST.

Business Opportunities.

Wanted—Factory to manufacture on royalty the best mine car wheel ever invented. Letter patent granted on same Feb. 27, 1906. For particulars write Dod Haslup, Grafton, W. Va.

Wanted—Active partner in machine shop to invest $5000. Now doing repair work. Want to manufacture such things as are needed in the south. South Georgia Iron Works, Valdosta, Ga.

Office or mechanical man to invest $10,000 to $15,000 with services in growing foundry and machine shop controling patent specialties, doubling its capacity the past 6 years. Good opportunity for young man. Address P. O. Box 1456, St. Louis, Mo.

A young man (29) who has had a technical education and eight years' experience selling machine and electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented on either salary or commission basis. Box 280, AMER. MACH.

A Manufacturing Concern having a varied line of machinery, wishes to dispose of one of its lines which consists of stationary gasolene engines. These engines run in sizes of from 2 to 20 H.P., and are adapted for all kinds of work. Business in this line has run $50,000.00 a year. Patterns, drawings and good will will be sold at a reasonable figure. Parties desiring to add another line to their business, or those desirous of going into the manufacturing business will find this to be an interesting proposition. Address Gas Engine, 260 AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Expert theoretical and practical gear cutter desires change. Box 277, AMER. MACH.

Position as superintendent in a factory manufacturing sheet brass goods; have had fifteen years' experience in that line in one of Waterbury's largest concerns. "Brass," Box 718, Waterbury Ct.

ILLINOIS.

Situation Wanted—Salesman general machinery or machinery specialties; technical graduate; 28 years old; 8 years' mechanical experience; 5 years' traveling; speak Spanish; unquestionable references. Box 262, A. M.

Superintendent or Foreman—High-class tool and die maker and machinist. Man of exceptional ability and originality; 20 years' experience on light and heavy interchangeable work; capable of removing obstacles in faulty constructed and poorly designed machines, reducing cost and bringing about phenomenal and satisfactory results; formerly superintendent of a large machine shop. Best of reference. Box 261, AMER. MACH.

IOWA.

Chief Draftsman; a mechanical engineer, at present chief draftsman with a large manufacturing concern in the west. Box 269, AMERICAN MACHINIST.

Wanted— position as superintendent or foreman of machine shop; up-to-date machine shop practice. Huster in producing work; expert on Corliss Hoisting or Haulage Engines; good reference. Box 276, AMERICAN MACH.

MARYLAND.

Designing draftsman (30), 9 years' experience on general machine design and construction, including dredging machinery, marine equipment, engines, boilers, conveyors, and general rolling mill and foundry equipment. Thoroughly acquainted with best shop practice. Large experience estimating material and figuring costs. Have technical education and executive ability. Can take entire charge in drawing room or field. Good reasons for desiring change. Would accept responsible position with first-class firm. Address Box 279, AMERICAN MACHINIST.

MASSACHUSETTS.

Factory office clerk. Several years experience in general office work, also as cost keeper, purchasing agent and systematizer. Box 281, AMERICAN MACHINIST.

NEW JERSEY.

Master mechanic with 15 years' experience in construction and repair work pumps, etc., in large factories. Box 179, AMER. MACH.

General foreman, 18 years shop practice; 10 years experience on high-grade machinery, familiar with the design and construction of jigs, fixtures and tools. Capable of producing up-to-date results. Box 263, AMER. MACH.

A young man (37) wth 21 years experience in the machine business desires a position as assistant superintendent. The past 13 years on pumping machinery of all kinds as machinist. In charge of piecework and shop costs and chief clerk for the past year with pump company employing 2300 men Highest reference. Box 274, AMERICAN MACH.

Mechanical and Electrical Engineer, technical graduate, extended experience as mechanical superintendent of large manufacturing plant and factory manager. Designing and installing, manufacturing, steam, electrical, fire protection equipment, and building, shop supervision modern tools and methods, successful in organizing and handling help. Box 272, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman and designer desires position. Box 278, AMERICAN MACHINIST.

Mechanical draftsman, with several years shop and office experience, wants position. Box 248, AMERICAN MACHINIST.

Superintendent or manager general machine and boiler shops; experienced on marine repairs. Box 266, AMERICAN MACHINIST.

Mechanical draughtsman, 6 years in draughting room, 3 years machinist, wants position. Automatic machinery preferred. Box 271, AMERICAN MACHINIST.

Machine shop foreman, familiar with modern methods, and interchangeable manufacture; technical graduate and a hustler; desires change. Box 232, AMER. MACH.

A-1 draughtsman, mechanical, seven years shop experience, four years draughting. General and special machinery. Desires to change. Box 265, AMERICAN MACHINIST.

A practical man making a specialty of the design and construction of jigs, fixtures and tools for the economical production of accurate, interchangeable parts. Box 264, AM. M.

First-class case and tool hardener; years of experience in high-grade automobile work. Practical all-round mechanic. Familiar with handling chrome nickel steel. E. W., 686 Hart St., Brooklyn.

Wanted—Position as works superintendent. At present assistant superintendent with large Corliss Engine Co. Familiar with modern methods. Machinist by trade. Member of the A. S. M. E. Box 203, AMER. MA.

Position wanted by mechanical designer of broad experience, inventor of speed changing device for machine tools that will give any ratio from standstill to maximum speed, no friction clutches. Investigate. P. O. Box 619, Schenectady, N. Y.

OHIO.

Position as draftsman; 28, practical machinist, technical graduate. Box 273, AM. M.

PENNSYLVANIA.

Experienced tool-maker; also competent at die and pattern-making; 10 years in shops; good education; wishes steady position. Philadelphia. Box 256, AMERICAN MACHINIST.

Toolmaker machinist, jig designer, wants position; manufacturing, tool-making, general work or partnership; 30 years; 4 years foreman; now has charge 30 men. Box 233, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Tool-makers, experienced on gauge, fixture and die work. Apply Ross Rifle Company, Quebec, Canada.

CONNECTICUT.

Wanted—Two first-class tool-makers on small, accurate work. The Veeder Mfg. Co., Hartford, Conn.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—A man for foreman of assembling department in adding machine factory. Must be a thorough mechanic, successful in handling men, and with full experience in this class of work. State age, nationality, experience and salary wanted. Address Box 267, AMERICAN MACHINIST.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Several machinists on small automatic machinery, tools and repair work. Permanent situation for competent men. A-1 factory in Worcester County. Box 213, AM. M.

Draftsmen—We have openings for three draftsmen who are well posted on mill construction. Vicinity of Boston. State age, experience in detail, and salary expected. Address "X Y Z." 238 AMER. MACHINIST.

Wanted—Eight tool makers for light machine and tool work. Up to date factory with modern equipment. Permanent positions for right men. Works situated in Worcester County. State experience, age and wages expected. Box 211, AMERICAN MACH.

Wanted—Six die makers for small punching, forming and embossing dies and tools, in first-class shop with up-to-date- machinery. Permanent situation if satisfactory. Factory in Central Mass. State age, experience and wages expected. Box 212, AMER CAN MACH.

MICHIGAN.

Wanted—Ten first-class die makers. Experienced on drawing, forming and blanking dies. New Modern Shop. Good wages to good men. Inventors' Mfg. Co., Kalamazoo, Mich. AMERICAN MACHINIST.

Wanted—Several first-class, experienced draftsmen, familiar with heavy engine designing. State wages desired and experience. Apply or address, Olds Gas Power Co., Lansing, Mich. AMERICAN MACHINIST.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Wanted—A young man with some drafting and mechanical ability to act as casting inspector. Benj. Atha & Co., Newark, N. J.

Wanted—Foreman for press room. Must be A-1 on drawing and shell dies. Address giving experience. Box 229, AMER. MACH.

Mechanical draftsman on printing machinery wanted. One capable of taking charge of designing a machine. Box 247, AMER. MA.

Wanted—Inspector, familiar with typewriter or similar work; must be competent to take charge of men; give experience and salary expected. Box 253, AMER. MACH.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—Master Mechanic, competent to take charge of large general manufacturing plant in New Jersey. First-class references required. Address Mechanic, 794 Broad St., Newark, N. J.

Wanted—Mechanical Draughtsman for special machinery, jigs, tools. One with shop experience preferred. Address with reference, age, experience and salary expected. Box 228, AMERICAN MACHINIST.

Wanted—Three first-class machine hands, Horizontal Bar Mill hands preferred; no labor troubles here; steady work at good wages to competent men. Apply immediately. The Reeves Engine Co., Trenton, N. J.

Wanted—Foundry Foreman to take charge of shop employing 70 men. One hour's ride from Philadelphia; must be a capable man, qualified to handle men and familiar with modern appliances. S. B. H., 192, AM. M.

NEW YORK.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Mechanical Draftsman. State age, nationality, experience and salary wanted. Box 234, AMERICAN MACHINIST.

Machinists—Wanted first-class all-around machinists. Apply, stating wages wanted. Gifford-Wood Co., Hudson, N. Y.

Wanted—First-class machinist; must be posted in all branches German; married man preferred; factory in country. Address Country, Permanent, 255 AMERICAN MACH.

Wanted—A few A-1 tool-makers on punch and die work. Give references, age, and wages expected. None but first-class men need apply. Remington Typewriter Co., Ilion, N. Y.

Toolmakers—Wanted immediately, first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—A competent engineer to take charge and care of several large buildings having heating plants. A good job for the right man. Place within ten miles of City Hall. Address A. B. C., 246 AMER. MACH.

Draftsman on dies, jigs and fixtures for light, interchangeable work. Location Central New York. Position permanent to competent men. State previous experience and salary required. Box 258, AMER. MACH.

Machinists—For floor work. Permanent employment for good men. Wages $2.50 per day; 9 hour work day; time and half for overtime, double time for holidays. Location 25 miles from New York City. Box 268, AMERICAN MACHINIST.

Pattern maker, or other person familiar with wood patterns, to systematize large pattern loft, making complete lists, marking and locating patterns systematically; several months' work; likely to lead to good permanent position; location Greater New York. State experience and references. Address Box 205, AMERICAN MACHINIST.

OHIO.

Wanted—First-class mechanical draftsmen, experienced in machine tool work. The Niles Tool Works Co., Hamilton, Ohio.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 270, AMERICAN MACH.

Wanted—An experienced storeroom keeper in machine shop of a plant employing one thousand men. Address box 236, AM MACH.

Wanted—Electrical Engineer; man familiar with direct and alternating currents on new work. State experience, references, age and wages expected. Box 249, AMERICAN MA.

A company employing about 250 men and building a line of machine tools wishes an assistant superintendent. The position requires a practical mechanic of executive ability and who has a faculty for handling men. Give references, state experience and name salary desired. Box 167, AMER. MACH.

Wanted—First-class man to take charge of designing of up-to-date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of the same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

Tool Designer wanted upon special tools, fixtures and gauges required for the manufacture of intricate mechanism; man familiar with tools used in making typewriters, sewing machines, small arms of calculating machines preferred. Give experience in detail, age, references and salary expected. Box 250, AMERICAN MACHINIST.

Wanted—Tool Department Foreman; must be good mechanic, with large experience on special tools, fixtures, gages, sheet metal cutting dies, plain, compound and sub-press; capable of handling about 200 tool and die makers, and understand modern shop methods, exceptional opportunity for the right man. Give experience in detail, age, references and salary expected. Box 251, AM. M.

Equipment Engineer wanted; man between 30 and 40 years of age, well educated, energetic and experienced in the manufacture of high-class, medium and small machine tools; capable of conducting negotiations for the purchase of tools and of preparing plans for the proper installation of machines in various departments. Give experience in detail also references and salary expected. Box 252, AMERICAN MACHINIST.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—First-class instrument and toolmakers; also large machine tool operators. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

The Monotype Company maintains a school to train young men to meet the constantly increasing demand for operators of its type casting and composing machine. These operators have done so well that it receives more applications for places than can be filled. In making selections these qualifications carry most weight; common sense, type-foundry experience, printing office experience, automatic machinery experience. Full particulars will be furnished to inquirers who furnish the same information about themselves. The Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Machinist Wanted—A reliable young man

INDIANAPOLIS
MAR 16 1906
PUBLIC LIBRARY

Notes on the Cam Chart.

BY JOHN ROY.

A good many years ago when I was an apprentice, a faithful and patient friend spent hours drumming into my head the mysteries of the cam chart. His methods were in a general way akin to those recently illustrated in the AMERICAN MACHINIST. When I left the employment of this friend, one of the first jobs I fell heir to was to complete the design of a cold header which had been schemed out and almost finished by a very able man, whose death had temporarily put an end to the work. It was a special machine for a special class of work, and nobody about the place was familiar with it, so very naturally the starting point was the cam chart, which I was horrified to find, looked like Fig. 1.

I will not venture to say how much time I put on this chart or how much midnight oil I burned on my own account in raveling this mystery, for such it was to me. I finally managed to reduce it to terms or ideas that I understood, and reconstructed the chart to look like Fig. 2. For awhile after that I was afraid to speak of a cam chart, lest some one would spring a new one on me which would leave me foundering again. Since that time I have been to college, studied text-books and professors, and glanced into many reference books without ever having seen or heard of a published word regarding the construction, use or theory of any kind of cam chart until the appearance of C. F. Smith's excellent articles in Vol. 28, Part 1, of the AMERICAN MACHINIST. I did not agree with him in every particular, but the worth of the paper was so apparent, and so far above anything I could do myself, that I determined not to confuse the readers by objections. However, a man should be pretty careful about what he puts into print, for cold type add a dignity and weight to an *opinion* which too frequently converts it into a *law* to those struggling for information. For this reason I wish he had discussed more at length cam and short systems different from his own (I am sure he has met with many such) and had gone through some process of elimination of the bad or worst ones. I have worked into, evolved, or absorbed a pretty definite method of procedure for the design of cams, yet I was startled the other week to find one of my young men breaking away from precedent and trying to lay out a cam as described in the article referred to, because he considered the said precedent bad and not according to the rules. Hence, in self defense, it seems, I must seek to *print* my ideas in order to keep them.

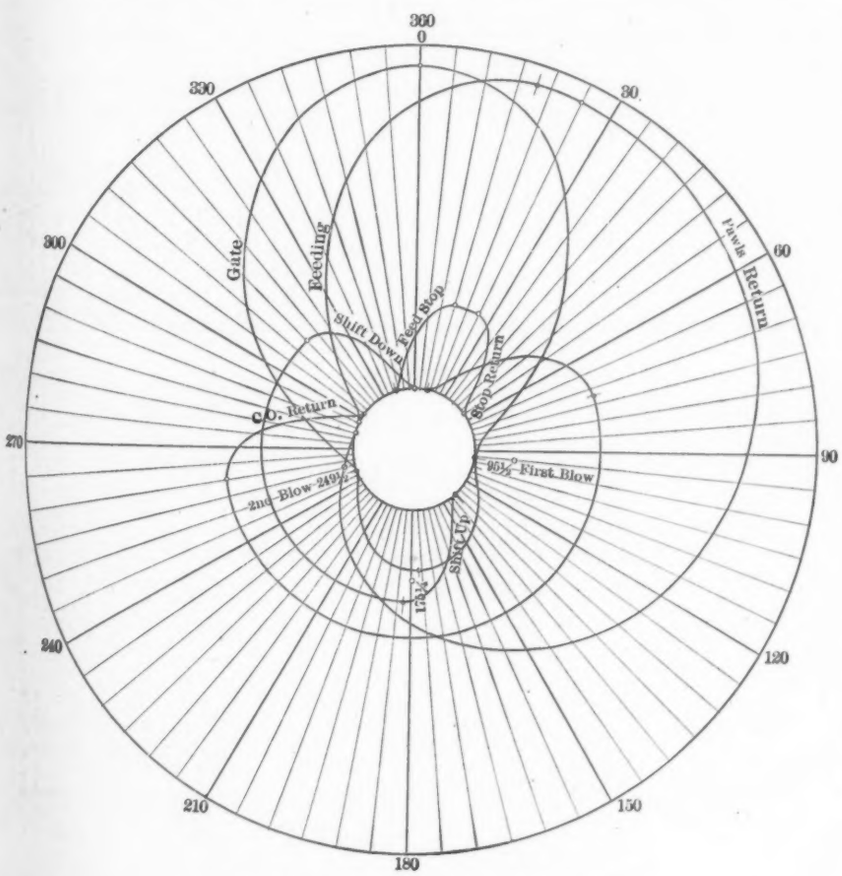


FIG. 1. AN UNDESIRABLE FORM OF CAM CHART.

I will do it categorically in the form of a comparison with Mr. Smith's articles.

1. Laying out the chart with cams overlapping.

I very much prefer to give each cam a separate base line and space all its own, as in Fig. 2. In this way the whole path of motion of any cam is seen at a glance, while to pick out a path from the chart facing page 382 is a job for a novice, and anyone is apt to lose it while hunting for another path to compare with it. In this way the numbering scheme, which was new to me, could be much more clearly carried through. Further, I like to see the motion of the real working point and throw of the cam both dimensioned on the chart, as shown in Figs. 2, 3 and 4. This practice will save a good deal of trouble and turning over of tracings. It will be seen that curve marked *Feed* in Fig. 2 has a separate base line, but cuts through and encroaches on the space reserved for *Stroke* of *Gate*. This is a perfectly legitimate and sometimes very useful exception to the rule. I may as well add at the start that I constantly take liberties with all these, my self-appointed guides, as every one should who is master of his own.

2. Sticking too close to the one machine for a type of cam chart, and thus giving the impression that it must always be elaborate and according to fixed rules.

For example, three weeks were spent on the chart mentioned. It is frequently necessary to have the complete set of drawings in the shop in that time. In designs where cam charts are necessary it rarely happens that more than two or three movements are so related that every point in their course must be known. Especially is this true in designs that are modifications or enlargements of existing types of machines. Mr. Smith states this plainly in the opening paragraph of his first article. For these few the precise accurate path may be plotted on the chart and the remainder and larger number simply represented by straight lines. All that is necessary to know, *i. e.*, where they start and stop, is thus shown. When there are several motions on a machine from 8 to 10 inches in length, it is desirable to scale them down to 2 or 3 inches for sake of clearer representation; in all cases, of course, putting the proper dimensions in place. Figs. 3 and 4 illustrate my meaning in these particulars. In curve, *"Nut Holder Out and In."* Fig. 3, the only portion plotted accurately is at *A* where it is necessary to know just when the safety must act. The only other curves whose paths it was desirable to know on this machine are shown as plotted curves; other times are indicated perfectly as well, and with less effort and time, by straight lines.

While it is very desirable to keep the cam path down to an angle of 30 degrees or less, it frequently cannot be done, and sometimes on rapid running machinery to increase the diameter of the cam to make

of the kind in the world, died March 1, aged 75 years.

John Milton Greist, president of the Greist Manufacturing Company of Westville, Conn., and one of the leading inventors and manufacturers of New England, died at his home in Westville, February 23, after an operation. Mr. Greist was born in Crawfordsville, Ind., and was 53 years old.

Edward Edwards, of Catasauqua, Penn., was stricken with apoplexy February 21 in his office at the Slatington Rolling Mills, of which he was president, and died during the night. Mr. Edwards was born in Wales 64 years ago, came to this country when a youth and learned iron-making under David and Samuel Thomas.

James A. Mason, assistant superintendent of the Blake & Johnson Company, Waterbury, Conn., died in that city, February 24, of Bright's disease, aged 34 years. Mr. Mason learned his trade at the Pratt & Whitney shops in Hartford and was employed at that place for about 15 years, the last four or five as a foreman. He had been located in Waterbury about two years.

Edwin Gilbert, president of the Gilbert & Bennet Manufacturing Company, of Georgetown, Conn., died March 1 at Crescent City, Fla., aged 80 years. He was born in Georgetown and had always lived there. He was one of the first to manufacture wire goods and was the inventor of machines which weave over a mile each of wire fencing in a day. After working for many years as a mechanic he became a manufacturer and thirty years ago organized the company of which he was president.

Samuel Thomas, a pioneer pig-iron manufacturer, died February 21 at his home in Catasauqua, Penn., after an illness of several months of kidney disease, aged 79 years. Mr. Thomas was born in Wales and was a son of David Thomas, who first successfully introduced in this country the anthracite blast for the manufacturer of pig iron. David Thomas and his son in 1854 organized the Thomas Iron Company, and established works at Hokendauqua, Penn. The company now operates twelve stacks in various parts of Pennsylvania.

John W. Babson, chief of the issue and gazette division of the United States Patent Office, died at his home in Washington, March 1, aged 71 years. He was born in Maine, was graduated from Maine Wesleyan College, where he afterward served as an instructor. He went to Washington in 1861 as secretary to the then Vice-President, Hannibal Hamlin, and in 1866 was transferred to the Patent Office. He served as departmentary commissioner of patents, chief of the pension division, and in charge of the official gazette, which was under his supervision up to the date of his death.

William Alfred Hovey, well known in journalistic and engineering circles, died at Boston, Mass., February 17, aged 64. Mr. Hovey for several years after the Civil war was connected with coal mining interests in Pennsylvania, as engineer and superintendent, and later removed to Chelsea, Mass., to conduct a weekly paper. In 1872 he became managing editor of the Boston *Commercial Bulletin* and in 1875 succeeded to the editorship of the *Transcript*, from which position he retired in 1881 to establish the *Manufacturers' Gazette*. Later he became president of the Merchants' Electric Light & Power Company, and then editor of the *Electrical Review* in 1884. Since 1885 he had been connected with the American Bell Telephone Company.

Samuel Pierpont Langley, secretary of the Smithsonian Institution at Washington and known throughout the world as a scientist, died after a second stroke of paralysis, February 27, at Aiken, S. C., aged 72 years. He was born in Roxbury, Mass., graduated from the Boston High School and early in life took up the practice of architecture and civil engineering. In 1865 he became an assistant in the Harvard observatory and in 1867 was appointed assistant professor of mathematics at the United States Naval Academy. The same year he was made a director of the Alleghany observatory, where he remained for twenty years. During this time he founded the system of standardization of time for railroads and invented the bolometer, a thermometer of extreme delicacy. In 1870 he began his studies in solar physics, a field in which he became a recognized authority. He was appointed secretary of the Smithsonian Institution in 1887 and later devoted much of his time to the study of aerial navigation, a field of effort which he abandoned a short time ago upon the failure of his experiments with an aeroplane propelled by a gasolene engine. Professor Langley was a prolific writer upon scientific subjects and a member of many scientific associations.

Business Items.

The Diamond Machine Co., of Providence, R. I., are opening a salesroom at 18 Dey Street, New York City, which will be in charge of H. F. Frevert. They will carry a full line of their grinding machines in stock and will be in position to make deliveries at short notice.

A new company has been incorporated at Buffalo, N. Y., to be known as the Buffalo Crucible Castings Co. It is capitalized at $150,000 and will manufacture crucible steel castings, for use in automobiles and the smaller machines. E. G. Ripple of the Buffalo Foundry Co., John L. Osgood, George Bleistein, A. W. Thorne and F. L. Bapst are the directors.

The Diehl Manufacturing Company has recently leased the entire building at 1305 Race St., Philadelphia, Pa., for use as a warehouse, and a complete stock of apparatus of all kinds will be carried. The large increase of the business of the Philadelphia office of the company has made this action necessary. The office still remains at 1217 Filbert St.

The Olds Gasolene Engine Works, Lansing, Michigan, have just announced the consolidation of their company with the American Suction Gas Producer Co., of the same city. This new company is to have a capitalization of $612,000 and is to be called the Olds Gas Power Co., the object of which is the manufacture of gas engines, gas producers and the smaller gasolene engines for various uses.

The Toledo Machine and Tool Co., of Toledo, Ohio, builders of bar and sheet metal working machinery as well as designers and builders of special machinery are experiencing a most gratifying increase of their export business and are receiving and shipping large orders to France, Germany, Belgium and Holland. A large business is also being done by this firm in Canada.

Manufacturers.

The Kellogg Iron Works of Buffalo, N. Y., will move to Hamburg N. Y.

The Iowa Ice Company, Des Moines, Iowa, will build an artificial ice plant.

The Dunkirk (N. Y.) Stone Company, is adding a boiler house and a wet kiln.

The Marshall-Wells Hardware Company, Duluth, Minn., will erect a new factory.

Joseph Bancroft & Sons, Wilmington, Del., cotton finishers, etc., will erect a new factory.

The Mexia (Texas) Light and Water Company is erecting a plant at Springfield, Tex.

The Automatic Machine Company, Bridgeport, Conn., is having an addition built to its shop.

P. Derby & Company of New York, will erect a $100,000 chair factory in Jersey City, N. J.

Fire destroyed the pant of the Willard Bag and Manufacturing Company, Wilmington, N. C.

The Portland (Ore.) General Electric Company will make extensive improvements at its plant.

The plant of the Howell's Mining Drill Company, Pymouth, Pa., will be increased in capacity.

A new foundry building is to be erected at the plant of the United States Sanitary Company at Monaca, Pa.

The Avonmore Cast Steel Company, of Uniontown Pa., has been incorporated with a capital of $150,000.

Greenlee Bros., Rockford, Ill., builders of special woodworking machinery, are planning to put up a large addition.

Plans are completed for the new power house to be erected by the Pittsfield (Mass.) Street Railroad Company.

It is reported that the Corbin Screw Company, New Britain, Conn., has in view the erection of a large plant.

The Berwind-White Coal Mining Company of Philadelphia, Pa., will erect car repair shops at East Hollidaysburg.

The New England Boiler Company has perfected plans for the erection of a new plant in New London, Conn.

The car shop of the Colorado & Southern Railroad at Denver, Colo., which burned lately will be rebuilt at once.

The Pittsburg Plate Glass Company has increased its capital stock and will erect another plant in Crystal City, Mo.

The William Powell Company, brass founders, Cincinnati, Ohio, will erect a new foundry building to cost $40,000.

Joseph Z. Collins, carriage builder, Camden, N. J., will erect a new building, equipped with steam heating and electric power.

The Kokomo (Ind.) plant of the Kokomo, Marion and Western Traction Company will be enlarged.

The city of Manitowoc, Wis., is considering a site for the proposed new municipal water works.

The factory of the J. L. Thompson Manufacturing Company, rivets, etc., Waltham, Mass., is being enlarged.

Work has been commenced on a new factory for the Hersey Manufacturing Company, Boston, Mass., making water meters, etc.

R. E. T. Pringle & Co., Ltd., Montreal, Canada, will build a new $30,000 electrical factory to be equipped with the latest machinery.

The plant of the Bellefontaine (Ohio) Bridge & Iron Company, destroyed by fire recently is to be rebuilt immediately on a larger scale.

The Utah Packing Company, Salt Lake City, has been reorganized and will put up a large plant. George C. Whitmore of Nephi, Utah, is president.

The electric power house for the terminal station of the Pennsylvania, New York and Long Island Railroad tunnel in New York, will cost $300,000.

The plant of the Northwestern Manufacturing Company, burned sometime ago, is to be rebuilt. The company manufactures wagons and chairs.

The Standard Knitting Mills, Knoxville, Tenn., will spend about $100,000 in improvements, which will include a new engine house, boiler house, yarn mill.

Plans have been completed for an addition to the present factory and a new factory for the E. A. Bliss Company, Meriden, Conn., manufacturing novelties.

Catalog Notices.

The Means Foundry & Machine Co., Steubenville, Ohio. Catalog of brass and bronze castings. Illustrated, 5½x8½, pp. 9, paper.

A. W. Harris Oil Company, Providence, R. I. Attractive booklet entitled "Petroleum Lubricating Oils" which describes the various oils made by this company. Illustrated, 4x8, pp. 32, paper.

Ingersoll-Rand Co., 11 Broadway, New York. Catalog No. 45, describing Ingersoll-Sergeant rock drills for mining, tunneling, quarrying, and general rock excavation. Illustrated, 6x9, pp. 96, paper.

Termaat & Monahan Co., Oshkosh, Wis. Catalog describing gasolene marine engines. Tables of sizes and weights and price lists are given, as well as line drawings showing principal dimensions. 5½x7½, pp. 40, paper.

American Locomotive Co., New York. Pamphlet entitled "Four-Cylinder Balanced Compound Locomotives," which is a reprint of a paper by F. J. Cole read before the Railway Club of Pittsburg. Illustrated, 6x9, pp. 32, paper.

The Vauxhall and West-Hydraulic Engineering Co., Ltd., 23 College Hill, London, E. C. Catalog of hydraulic and arsenal machinery. This is a very comprehensive book, printed on fine coated paper and containing numerous half-tone illustrations. 8½x11, pp. 189, cloth.

Hyatt Roller Bearing Co., Harrison, N. J. Bulletin No. 28. This gives a resume of the advantages and applications of the Hyatt bearing, and shows a number of applications which have been commercially made of these bearings under various conditions. List of users, tables of dimensions, line and half-tone engravings, are also given. Copy of the bulletin will be sent to anyone interested on application. 6½x8½, pp. 46, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Wanted—Pressure Blower, capacity about same as Root's No. 5. Address Brown, P. O. Drawer 6, New Haven, Conn.

Mechanical draftsman (locomotive) going to Germany 3 months, desires to represent some concern. Box 254, AMER. MACH.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia.

Work Wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

Any kind development work, special automatic machines, gas engines, automobiles, etc., designed. H. P. Moorees, M. E., E. E., 7 East 42nd st., New York City.

Wanted, at once, a 36-inch lathe, screw-cutting attachments, short bed. Must be in condition to turn out perfect work. Address X. 257, AMERICAN MACHINIST, stating full particulars.

Well-known firm desires for Germany the sole agency for plain and universal Internal Grinding Machines 12 inches by 40 inches between centers, as well as for other modern machinery, viz., Automatic Screw Machines, etc. Address H. 3. 12377, care Haasenstein & Vogler A. G., Hamburg, Germany.

Wanted—For large manufacturing concern in Illinois, first-class up-to-date man as foreman of machine shop, large department, fairly heavy work. Also a foreman of small blacksmith shop who would be willing to run a fire himself when necessary. Engineering Agency, Monadnock Block, Chicago.

Draftsmen—Experienced detailers and designers on electrical and mechanical work—gas and steam engines jigs, dies and tools, pumping machinery, transformers, motors, generators, etc.: $65—$130; over 100 positions open. Write for Vacancy List. Engineering Agency, Inc., Diamond Bank Bldg., Pittsburg, Pa.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

For Sale.

For Sale—1000 Steam and Water gauges at $1 each. Send for list to J. L. Lucas, 2 Fox st., Bridgeport, Conn.

Foundry machine and boiler plant. $14,000. $6,000 will buy it. A rare chance. Address F. Palfrey, Macon, Mo.

For Rent—Small factory at Plainfield; gasolene engine, railroad siding; $25 per month. A. J. Brunson, Painfield, N. J.

For Sale—Gas engine business with engines from two to sixty horse power capacity. Stock of finished and unfinished engines and patterns, drawings, etc. Will sell at a bargain. Apply Box 55, AMERICAN MACHINIST.

Business Opportunities.

Wanted—Factory to manufacture on royalty the best mine car wheel ever invented. Letter patent granted on same Feb. 27, 1906. For particulars write Dod Haslup, Grafton, W. Va.

Wanted—Active partner in machine shop to invest $5000. Now doing repair work. Want to manufacture such things as are needed in the south. South Georgia Iron Works, Valdosta, Ga.

Office or mechanical man to invest $10,000 to $15,000 with services in growing foundry and machine shop controling patent specialties, doubling its capacity the past 6 years. Good opportunity for young man. Address P. O. Box 1456, St. Louis, Mo.

A young man (29) who has had a technical education and eight years' experience selling machine and electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented on either salary or commission basis. Box 280, AMER. MACH.

A Manufacturing Concern having a varied line of machinery, wishes to dispose of one of its lines which consists of stationary gasolene engines. These engines run in sizes of from 2 to 20 H.P., and are adapted for all kinds of work. Business in this line has run $50,000.00 a year. Patterns, drawings and good will will be sold at a reasonable figure. Parties desiring to add another line to their business, or those desirous of going into the manufacturing business will find this to be an interesting proposition. Address Gas Engine, 260 AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Expert theoretical and practical gear cutter desires change. Box 277, AMER. MACH.

Position as superintendent in a factory manufacturing sheet brass goods; have had fifteen years' experience in that line in one of Waterbury's largest concerns. "Brass," Box 718, Waterbury Ct.

ILLINOIS.

Situation Wanted—Salesman general machinery or machinery specialties; technical graduate; 28 years old; 8 years' mechanical experience; 5 years' traveling; speak Spanish; unquestionable references. Box 262, A. M.

Superintendent or Foreman—High-class tool and die maker and machinist. Man of exceptional ability and originality; 20 years' experience on light and heavy interchangeable work; capable of removing obstacles in faulty constructed and poorly designed machines, reducing cost and bringing about phenomenal and satisfactory results; formerly superintendent of a large machine shop. Best of reference. Box 261, AMER. MACH.

IOWA.

Chief Draftsman; a mechanical engineer, at present chief draftsman with a large manufacturing concern in the west. Box 269, AMERICAN MACHINIST.

Wanted—position as superintendent or foreman of machine shop; up-to-date machine shop practice. Huster in producing work; expert on Corliss Hoisting or Haulage Engines; good reference. Box 276, AMERICAN MACH.

MARYLAND.

Designing draftsman (30), 9 years' experience on general machine design and construction, including dredging machinery, marine equipment, engines, boilers, conveyors, and general rolling mill and foundry equipment. Thoroughly acquainted with best shop practice. Large experience estimating material and figuring costs. Have technical education and executive ability. Can take entire charge in drawing room or field. Good reasons for desiring change. Would accept responsible position with first-class firm. Address Box 279, AMERICAN MACHINIST.

MASSACHUSETTS.

Factory office clerk. Several years experience in general office work, also as cost keeper, purchasing agent and systematizer. Box 281, AMERICAN MACHINIST.

NEW JERSEY.

Master mechanic with 15 years' experience in construction and repair work pumps, etc., in large factories. Box 179, AMER. MACH.

General foreman, 18 years shop practice; 10 years experience on high-grade machinery; familiar with the design and construction of jigs, fixtures and tools. Capable of producing up-to-date results. Box 263, AMER. MACH.

A young man (37) wth 21 years experience in the machine business desires a position as assistant superintendent. The past 13 years on pumping machinery of all kinds as machinist. In charge of piecework and shop costs and chief clerk for the past year with pump company employing 2300 men. Highest reference. Box 274, AMERICAN MACH.

Mechanical and Electrical Engineer, technical graduate, extended experience as mechanical superintendent of large manufacturing plant and factory manager. Designing and installing, manufacturing, steam, electrical, fire protection equipment, and building, shop supervision modern tools and methods, successful in organizing and handling help. Box 272, AMERICAN MACHINIST.

NEW YORK.

Mechanical draftsman and designer desires position. Box 278, AMERICAN MACHINIST.

Mechanical draftsman, with several years shop and office experience, wants position. Box 248, AMERICAN MACHINIST.

Superintendent or manager general machine and boiler shops; experienced on marine repairs. Box 266, AMERICAN MACHINIST.

Mechanical draughtsman, 6 years in draughting room, 3 years machinist, wants position. Automatic machinery preferred. Box 271, AMERICAN MACHINIST.

Machine shop foreman, familiar with modern methods, and interchangeable manufacture; technical graduate and a hustler; desires change. Box 232, AMER. MACH.

A-1 draughtsman, mechanical, seven years shop experience, four years draughting. General and special machinery. Desires to change. Box 265, AMERICAN MACHINIST.

A practical man making a specialty of the design and construction of jigs, fixtures and tools for the economical production of accurate, interchangeable parts. Box 264, AM. M.

First-class case and tool hardener; years of experience in high-grade automobile work. Practical all-round mechanic. Familiar with handling chrome nickel steel. E. W., 686 Hart St., Brooklyn.

Wanted—Position as works superintendent. At present assistant superintendent with large Corliss Engine Co. Familiar with modern methods. Machinist by trade. Member of the A. S. M. E. Box 203, AMER. MA.

Position wanted by mechanical designer of broad experience, inventor of speed changing device for machine tools that will give any ratio from standstill to maximum speed, no friction clutches. Investigate. P. O. Box 619, Schenectady, N. Y.

OHIO.

Position as draftsman; 28, practical machinist, technical graduate. Box 273, AM. M.

PENNSYLVANIA.

Experienced tool-maker; also competent at die and pattern-making; 10 years in shops; good education; wishes steady position. Philadelphia. Box 256, AMERICAN MACHINIST.

Toolmaker machinist, jig designer, wants position; manufacturing, tool-making, general work or partnership; 30 years; 4 years foreman; now has charge 30 men. Box 233, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Tool-makers, experienced on gauge, fixture and die work. Apply Ross Rifle Company, Quebec, Canada.

CONNECTICUT.

Wanted—Two first-class tool-makers on small, accurate work. The Veeder Mfg. Co., Hartford, Conn.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—A man for foreman of assembling department in adding machine factory. Must be a thorough mechanic, successful in handling men, and with full experience in this class of work. State age, nationality, experience and salary wanted. Address Box 267, AMERICAN MACHINIST.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Several machinists on small automatic machinery, tools and repair work. Permanent situation for competent men. A-1 factory in Worcester County. Box 213, AM. M.

Draftsmen—We have openings for three draftsmen who are well posted on mill construction. Vicinity of Boston. State age, experience in detail, and salary expected. Address "X Y Z." 238 AMER. MACHINIST.

Wanted—Eight tool makers for light machine and tool work. Up to date factory with modern equipment. Permanent positions for right men. Works situated in Worcester County. State experience, age and wages expected. Box 211, AMERICAN MACH.

Wanted—Six die makers for small punching, forming and embossing dies and tools, in first-class shop with up-to-date machinery. Permanent situation if satisfactory. Factory in Central Mass. State age, experience and wages expected. Box 212, AMERICAN MACH.

MICHIGAN.

Wanted—Ten first-class die makers. Experienced on drawing, forming and blanking dies. New Modern Shop. Good wages to good men. Inventors' Mfg. Co., Kalamazoo, Mich. AMERICAN MACHINIST.

Wanted—Several first-class, experienced draftsmen, familiar with heavy engine designing. State wages desired and experience. Apply or address, Olds Gas Power Co., Lansing, Mich. AMERICAN MACHINIST.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Wanted—A young man with some drafting and mechanical ability to act as casting inspector. Benj. Atha & Co., Newark, N. J.

Wanted—Foreman for press room. Must be A-1 on drawing and shell dies. Address giving experience. Box 229, AMER. MACH.

Mechanical draftsman on printing machinery wanted. One capable of taking charge of designing a machine. Box 247, AMER. MA.

Wanted—Inspector, familiar with typewriter or similar work; must be competent to take charge of men; give experience and salary expected. Box 253, AMER. MACH.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—Master Mechanic, competent to take charge of large general manufacturing plant in New Jersey. First-class references required. Address Mechanic, 794 Broad St., Newark, N. J.

Wanted—Mechanical Draughtsman for special machinery, jigs, tools. One with shop experience preferred. Address with reference, age, experience and salary expected. Box 228, AMERICAN MACHINIST.

Wanted—Three first-class machine hands, Horizontal Bar Mill hands preferred; no labor troubles here; steady work at good wages to competent men. Apply immediately. The Reeves Engine Co., Trenton, N. J.

Wanted—Foundry Foreman to take charge of shop employing 70 men. One hour's ride from Philadelphia; must be a capable man, qualified to handle men and familiar with modern appliances. S. B. H., 192, AM. M.

NEW YORK.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Mechanical Draftsman. State age, nationality, experience and salary wanted. Box 234, AMERICAN MACHINIST.

Machinists—Wanted first-class all-around machinists. Apply, stating wages wanted. Gifford-Wood Co., Hudson, N. Y.

Wanted—First-class machinist; must be posted in all branches German; married man preferred; factory in country. Address Country, Permanent, 255 AMERICAN MACH.

Wanted—A few A-1 tool-makers on punch and die work. Give references, age, and wages expected. None but first-class men need apply. Remington Typewriter Co., Ilion, N. Y.

Toolmakers—Wanted immediately, first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—A competent engineer to take charge and care of several large buildings having heating plants. A good job for the right man. Place within ten miles of City Hall. Address A. B. C., 246 AMER. MACH.

Draftsman, on dies, jigs and fixtures for light, interchangeable work. Location Central New York. Position permanent to competent men. State previous experience and salary required. Box 258, AMER. MACH.

Machinists—For floor work. Permanent employment for good men. Wages $2.50 per day; 9 hour work day; time and half for overtime, double time for holidays. Location 25 miles from New York City. Box 268, AMERICAN MACHINIST.

Pattern maker, or other person familiar with wood patterns, to systematize large pattern loft, making complete lists, marking and locating patterns systematically; several months' work; likely to lead to good permanent position; location Greater New York. State experience and references. Address Box 205, AMERICAN MACHINIST.

OHIO.

Wanted—First-class mechanical draftsmen, experienced in machine tool work. The Niles Tool Works Co., Hamilton, Ohio.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 270, AMERICAN MACH.

Wanted—An experienced storeroom keeper in machine shop of a plant employing one thousand men. Address box 236, AM MACH.

Wanted—Electrical Engineer; man familiar with direct and alternating currents on new work. State experience, references, age and wages expected. Box 249, AMERICAN MA.

A company employing about 250 men and building a line of machine tools wishes an assistant superintendent. The position requires a practical mechanic of executive ability and who has a faculty for handling men. Give references, state experience and name salary desired. Box 167, AMER. MACH.

Wanted—First-class man to take charge of designing of up-to-date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of the same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

Tool Designer wanted upon special tools, fixtures and gauges required for the manufacture of intricate mechanism; man familiar with tools used in making typewriters, sewing machines, small arms of calculating machines preferred. Give experience in detail, age, references and salary expected. Box 250, AMERICAN MACHINIST.

Wanted—Tool Department Foreman; must be good mechanic, with large experience on special tools, fixtures, gages, sheet metal cutting dies, plain, compound and sub-press; capable of handling about 200 tool and die makers, and understand modern shop methods, exceptional opportunity for the right man. Give experience in detail, age, references and salary expected. Box 251, AM. M.

Equipment Engineer wanted; man between 30 and 40 years of age, well educated, energetic and experienced in the manufacture of high-class, medium and small machine tools; capable of conducting negotiations for the purchase of tools and of preparing plans for the proper installation of machines in various departments. Give experience in detail also references and salary expected. Box 252, AMERICAN MACHINIST.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—First-class instrument and toolmakers; also large machine tool operators. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

The Monotype Company maintains a school to train young men to meet the constantly increasing demand for operators of its type casting and composing machine. These operators have done so well that it receives more applications for places than can be filled. In making selections these qualifications carry most weight; common sense, type-foundry experience, printing office experience, automatic machinery experience. Full particulars will be furnished to inquirers who furnish the same information about themselves. The Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Machinist Wanted—A reliable young man

in Eastern City to work on tools and take charge of small job. Good wages and steady work to the right man. Box 259, AM. M.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—Machinists ambitious to be foremen or sub-foremen. Our growing automobile business often furnishes opportunity for advancement. Thomas B. Jeffery & Co., Kenosha, Wis., Rambler Automobiles.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Wanted—General Superintendent to take charge of factory employing three-hundred hands; one having had experience in making typewriters or adding machines preferred. Give experience, references and salary expected. Box 275, AMERICAN MACHINIST.

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Wiley & Sons, Jno., New York.

Boosters
C & C Elec. Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Boring and Drilling Machines, Horizontal
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Betts Mach. Co., Wilmington, Del.
Binsse Mach. Co., Newark, N. J.
Boynton & Plummer, Worcester, Mass.
Detrick & Harvey Mach. Co., Baltimore, Md.
Fitchburg Machine Works, Fitchburg, Mass.
Fosdick Mach. Tool Co., Cin., O.
Gisholt Mach. Co., Madison, Wis.
Hill, Clarke & Co., Boston, Mass.
Lucas Mach. Tool Co., Cleve., O.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pawling & Harnischfeger, Milwaukee, Wis.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co, New York.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.

Boring and Turning Mills
American Tool Wks., Co., Cin., O.
Baker Bros., Toledo O.
Baush Mach. Tool Co., Springfield, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Betts Mach. Co., Wilmington, Del.
Bullard Mach. Tool Co., Bridgeport, Conn.
Colburn Mch. Tool Co., Franklin Pa.
Gisholt Mach. Co., Madison, Wis.
Harrington, Son & Co., Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
King Mach. Tool Co., Cincin., O.
McCabe, J. J., New York.
Niles-Bement-Pond Co., New York.
Poole Co., J. Morton, Wilmington, Del.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.
Warner & Swasey Co., Cleveland, Ohio.

Boring Tools
Armstrong Bros. Tool Co., Chicago, Ill.

Brackets, Lamp
Standard Welding Co., Cleve., O.

Bulldozers
Prentiss Tool & Supply Co., New York.

Cabinets, Tool
Armstrong Bros. Tool Co., Chicago, Ill.

Calipers
Brown & Sharpe Mfg. Co., Providence, R. I.
Slocomb Co., J. T., Providence, R. I.
Starrett Co., L. S., Athol, Mass.

Cams
Boston Gear Works, Boston, Mass.

Carborundum
See Grinding Wheels.

Castings, Brass
Nolte Brass Co., Springfield, O.
Phosphor Bronze Smelting Co., Phila., Pa.

Castings, Die Molded
Franklin Mfg. Co., Syracuse, N. Y.

Castings, Iron
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Massey Mach. Co., Watertown, N. Y.
Poole Co., J. Morton, Wilmington, Del.
United Engineering & Fdry. Co., Pittsburg, Pa.
U. S Foundry & Sales Co., South Norwalk, Conn.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
Phoenix Mfg. Co., Hartford Ct.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Boston, Mass.
Diamond Chain & Mfg. Co., Indianapolis, Ind.

Chains, Driving—*Continued.*
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Morse Chain Co., Trumansburg, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Baisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., The E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford Conn.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Horton & Son, Co., The E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., N. Y.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

CHAIN DEPARTMENT

Roller Chains Block Chains

"Wizard" Chains.

MACHINE DEPARTMENT

Hand and Weight (feed) Milling Machines,
20-inch Water Tool Grinders.

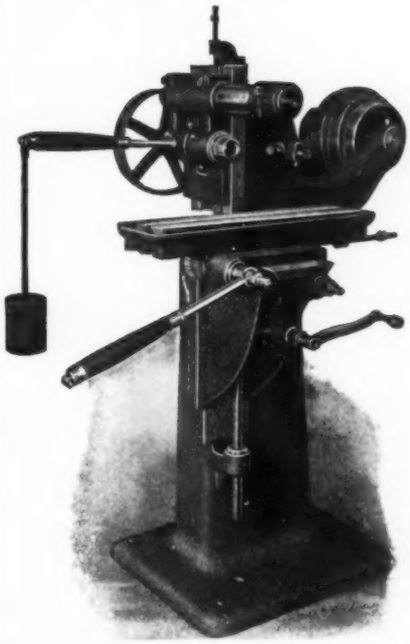
MISCELLANEOUS DEPARTMENT.

Keys and Cutters for the Woodruff Patent System of Keying

"Presto" Chucks, Collets and Friction Tapping Devices

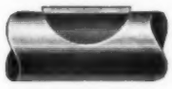
Sprockets for "Wizard" Chains

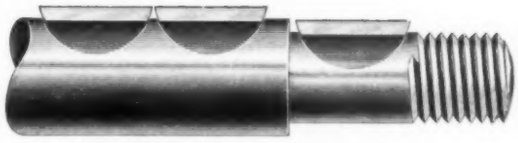
Hartford Printer.



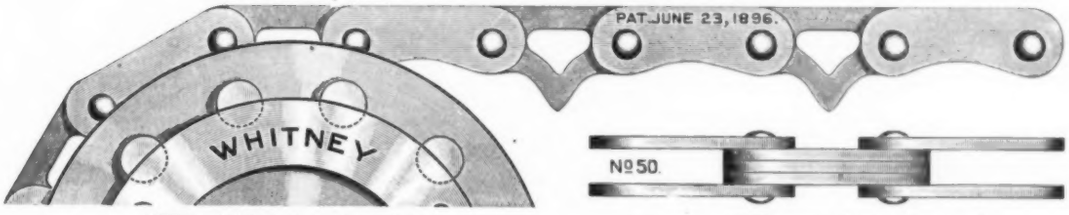
Patented.

Patented.





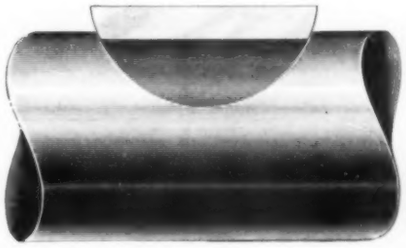
The Woodruff Patent System of Keying.



"Wizard" Sprocket, Patented.

"Wizard" Chain, Patented.

Patented.



THE
WHITNEY MFG. CO.
Hartford, Conn., U. S. A.

Coils
Standard Welding Co., Cleve., O.

Compounds, Boiler
Advance Mfg. Co., Kalamazoo, Mich.

Compounds, Pipe Joint
Dixon Crucible Co., Jos., Jersey City, N. J.

Compressors, Air
Blaisdell Mchy. Co., Bradford, Pa.
Blanchard Mach. Co., Boston, Mass.
Bury Compressor Co., Erie, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Mietz, August, New York.

Compressors, Gas
Ingersoll-Rand Co., New York.

Condensers
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.

Conduit, Interior
Sprague Elec. Co., New York.

Cones, Friction
Evans Friction Cone Co., Boston, Mass.

Connecting Rods and Straps
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Contract Work
Blanchard Mach. Co., Boston, Mass.

Controllers and Starters, Electric Motor
Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Coping Machines
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.

Correspondence Schools
See Schools, Correspondence.

Cotters
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Counterbores
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Slocomb Co., J. T., Prov., R. I.

Counters, Machinery
Durbrow & Hearne Mfg. Co., New York.

Countershafts
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Builders' Iron Fdry., Prov., R. I.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.

Countershafts, Friction
Wilmarth & Morman Co., Grand Rapids, Mich.

Countershafts, Speed Changing
Cresson Co., Geo. V., Phila., Pa.
Gisholt Mach. Co., Madison, Wis.
Reeves Pulley Co., Columbus, Ind.
Speed Changing Pulley Co., Indianapolis, Ind.

Counting and Printing Wheels
Franklin Mfg. Co., Syracuse, N. Y

Couplers, Hose
Ingersoll-Rand Co., New York.

Couplings, Shaft
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo V., Phila., Pa.
Link-Belt Engineering Co., Philadelphia, Pa.
Nicholson & Co., W. H., Wilkesbarre, Pa.

Couplings, Shaft —*Continued.*
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter Ltd., New York.
Standard Gauge Steel Co., Beaver Falls, Pa.
Woods Sons Co., T. B., Chambersburg, Pa.

Cranes
Alliance Machine Co., Alliance, Ohio.
Brown Hoisting Mach. Co., New York.
Case Mfg. Co., Columbus, O.
Cleveland Crane & Car Co., Wickliffe, O.
Crescent Forgings Co., Oakmont, Pa.
Curtis & Co., Mfg. Co., St. Louis, Mo.
Frevert Mfg. Co., New York.
General Pneumatic Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Obermayer Co., S., Cncinnati, O.
Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Yale & Towne Mfg. Co., New York.

Cranes, Portable
Franklin Portable Crane & Hoist Co., Franklin, Pa.
Nicholls, Wm. S., New York.

Crank Pin Turning Machine
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Crank Shafts
Standard Connecting Rod Co., Beaver Falls, Pa.
Tindel-Morris Co., Eddystone, Pa.

Crucibles
Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S., Cincinnati, O.

Crushers
Ingersoll-Rand Co., New York.
Link-Belt Engineering Co., Philadelphia, Pa

Cupolas, and Ladles, Foundry
Obermayer Co., S., Cncinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.

Cups and Covers, Oil
Bay State Stamping Works, Worcester, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Elliott Chemical Works, Newton, Mass.
Winkley Co., Detroit, Mich.

Cut Meters
Warner Instrument Co., Beloit, Wis.

Cutters, Milling
Adams Co., Dubuque, Iowa.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Boker & Co., Hermann, New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Twist Drill Co., Cleveland, O.
Ingersoll Milling Mach. Co., Rockford, Ill.
International High Speed Steel Co., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Ct.

Cutting-off Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Fawcus Mach. Co., Pittsburg, Pa.
Hill, Clarke & Co., Boston, Mass.
Hurlbut-Rogers Mach. Co., South Sudbury, Mass.
Newton Machine Tool Works, Philadelphia, Pa.

Cutting-off Machines *Continued.*
Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Cutting-off Tools
Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.

Diamond Tools
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Dies, Sheet Metal
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Kent & Co., Edwin R., Chicago, Ill.

Dies, Sub-Press
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Errington, F. A., New York.
Geometric Tool Co., New Haven, Conn.
Jones & Lamson Mch. Co., Springfield, Vt.
Pratt & Whitney Co., Hartford, Conn.
Swaine Co., Fred J., St. Louis, Mo.

Dowel Pins
Winkley Co., Detroit, Mich.

Drawing Boards and Tables
Keuffel & Esser Co., New York.
Obermayer Co., S., Cincinnati, O.
Rich Co., J. & G., Phila., Pa.

Drawing Materials
Alteneder & Sons, Theo., Phila., Pa.
Kelsey, D. J., New Haven, Conn.
Keuffel & Esser Co., New York.
Rich Co., J. & G., Phila., Pa.

Drafting Machines
Universal Drafting Mach. Co., Cleveland, O.

Drift Bolt Drivers
Ingersoll-Rand Co., New York.

Drilling Machines, Bench
American Watch Tool Co., Waltham, Mass.
Barnes Co., B F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Ingersoll-Rand Co., New York.
McGeorge & Sons, Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Sloane & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Multiple Spindle
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach. Co., New York.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.

Drilling Machines, Multiple Spindle —*Continued.*
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Drilling Machines, Turret
Niles-Bement-Pond Co., New York.

Drilling Machines, Upright
American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Beaman & Smith Co., Prov., R. I.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Boynton & Plummer, Worcester, Mass.
Cincinnati Mach. Tool Co., Cincinnati, O.
Fairbanks Co., New York.
Fenn-Sadler Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
Marshall & Huschart Mchry. Co., Chicago, Ill.
McCabe, J. J., New York.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Sibley Machine Tool Co., South Bend, Ind.
Sloane & Chace Mfg. Co., Newark, N. J.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Drills, Center
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Providence, R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

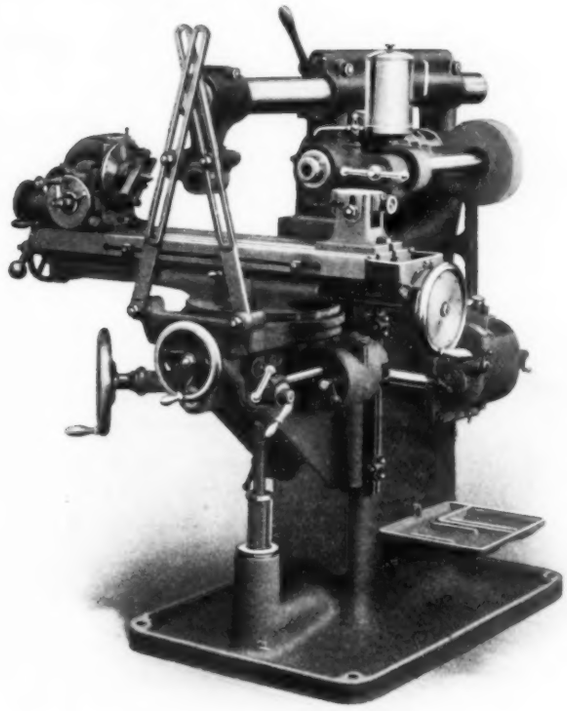
Brown & Sharpe Manufacturing Co.

Providence, R I., U. S. A.

ATTENTION TO DETAIL

A Characteristic Feature in the Construction of

B. & S. Milling Machines.



Suitable oil pans and channels are provided for the table. The base has an oil rim to protect the floor from waste oil.

All oil holes are carefully protected from dust and dirt.

Screws and nuts needing frequent adjustment are hardened.

The feed screw and gears in the knee are well protected from injury by suitable covers.

Rack for holding wrenches and pans for holding small parts are conveniently placed.

Levers and hand wheels are arranged for a quick and easy manipulation of the machine.

The manufacture of every part of the machine undergoes a rigid inspection.

Circulars, describing the Milling Machines in detail, sent upon request.

Drills, Pneumatic

Cleveland Pneu. Tool Co., Cleveland, O.
General Pneu. Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Rail

Foote, Burt & Co., Cleveland, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Standard Tool Co., Cleveland, O.

Drills, Ratchet

Armstrong Bros. Tool Co., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
Parker Co., Chas., Meriden, Conn.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Standard Tool Co., Cleveland, O.

Drills, Rock

Ingersoll-Rand Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.

Drying Apparatus

Sturtevant Co., B. F., Hyde Park, Mass.

Dynamos

C & C Electric Co., New York.
Crocker-Wheeler Co., Ampere, N. J.
Eck Dynamo & Motor Works, Belleville, N. J.
Electro Dynamic Co., Bayonne, N. J.
General Electric Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I., Elec. Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Triumph Elec. Co., Cincin., O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Dynamotors

Sprague Elec. Co., New York.

Electrical Supplies

D'Olier & Co., H., Phila., Pa.
Electro Dynamic Co., Bayonne, N. J.
General Elec. Co., New York.
Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Electrically Driven Tools and Machinery

American Tool Wks. Co., Cin., O.
Cincinnati Electrical Tool Co., Cincinnati, O.
Crescent Forgings Co., Oakmont, Pa.
Hisey-Wolf Mach. Co., Cincin., O.

Elevators

Albro-Clem Elevator Co., Philadelphia, Pa.
Curtis & Co. Mfg. Co., St. Louis, Mo.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Link-Belt Engineering Co., Philadelphia, Pa.

Emery Wheels

See Grinding Wheels

Emery Wheel Dressers

Desmond-Stephan Mfg. Co., Urbana, O.
Heald Machine Co., Worcester, Mass.
International Specialty Co., Detroit, Mich.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.

Enclosures, Tool-room

Merritt & Co., Philadelphia, Pa.

Engineers, Consulting and Mechanical

Dodge & Day, Philadelphia, Pa.
Roedder, O. C., Karlsruhe, Germany.

Engineers, Electrical

Crocker-Wheeler Co., Ampere, N. J.
Dodge & Day, Phila., Pa.

Engines, Automobile

Franklin Mfg. Co., Syracuse, N. Y.
Olds Gas Power Co., Lansing, Mich.
Reeves Pulley Co., Columbus, O.

Engines, Gas and Gasoline

Automatic Mach. Co., Bridgeport, Conn.
Backus Water Motor Co., Newark, N. J.
Blaisdell Machinery Co., Bradford, Pa.
Brown-Cochran Co., Lorain, O.
Columbus Mach. Co., Columbus, O.
Foos Gas Engine Co., Springfield, Ohio.
Jacobson Mach. & Mfg. Co., Warren, Pa.
Mietz, August, New York.
New Era Engine Co., Dayton, Ohio.
Olds Gas Power Co., Lansing, Mich.
Struthers-Wells Co., Warren, Pa.

Engines, Oil

Mietz, August, New York.

Engines, Steam

Buffalo Forge Co., Buffalo, N. Y.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Struthers-Wells Co., Warren, Pa.
Sturtevant Co., B. F., Hyde Park, Mass.

Engraving Machinery

Gorton Mach. Co., Geo., Racine, Wis.

Exhaust Heads

Sturtevant Co., B. F., Hyde Park, Mass.

Exhibition Machinery

Philadelphia Bourse, Phila., Pa.

Expanders, Boiler Tube

Nicholson & Co., W. H., Wilkesbarre, Pa.

Fans, Electric

Crocker-Wheeler Co., Ampere, N. J.
Diehl Mfg. Co., Elizabethport, N. J.
General Electric Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Fans, Exhaust

Buffalo Forge Co., Buffalo, N. Y.
Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Feathers

Standard Gauge Steel Co., Beaver Falls, Pa.

Files and Rasps

Barnett Co., G. & H., Phila., Pa.
Hammacher, Schlemmer & Co., New York.
Nicholson File Co., Prov., R. I.
Reichhelm & Co., E. P., New York.

Filing Machines

Detrick & Harvey Mach. Co., Baltimore, Md.
Henry & Wright Mfg. Co., Hartford, Conn.

Flexible Shafts

Chicago Flexible Shaft Co., Chicago, Ill.
Coates Clipper Mfg. Co., Worcester, Mass.

Forges

Boynton & Plummer, Worcester, Mass.
Buffalo Forge Co., Buffalo, N. Y.
Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Patterson, Gottfried & Hunter, Ltd., New York.
Prentiss Tool & Supply Co., New York.
Sturtevant Co., B. F., Hyde Park, Mass.

Forgings, Drop

Billings & Spencer Co., Hartford, Conn.
Crescent Forgings Co., Oakmont, Pa.
Wyman & Gordon, Worcester, Mass.

Forgings, Hydraulic

Wyman & Gordon, Worcester, Mass.

Forgings, Steel

Baldwin Steel Co., New York.
Boker & Co., Hermann, N. Y.
Crescent Forgings Co., Oakmont, Pa.
Heppenstall Forge & Knife Co., Pittsburg, Pa.
Kent & Co., Edwin R., Chicago, Ill.
Tindel-Morris Co., Eddystone, Pa.
Wyman & Gordon, Worcester, Mass.

Foundry Furnishings

Adams Co., Dubuque, Iowa.
Ingersoll-Rand Co., New York.
Obermayer Co., S., Cincinnati, O.
Paxson Co., J. W., Phila., Pa.
Stevens, F. B., Detroit, Mich.
Sturtevant Co., B. F., Hyde Park, Mass.

Fuel Economizers

Sturtevant Co., B. F., Boston, Mass.

Furnaces, Annealing and Tempering

American Gas Furnace Co., New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Furnaces, Enameling

American Gas Furnace Co., New York.

Furnaces, Gas

Am. Gas Furnace Co., N. Y. City.
Chicago Flexible Shaft Co., Chicago, Ill.
Obermayer Co., S., Cincinnati, O.
Westmacott Co., J. M., Providence, R. I.

Furnaces, Melting

American Gas Furnace Co., New York.

Furniture, Machine Shop

Manufacturing Equip. & Engineering Co., E. Boston, Mass.
Merritt & Co., Philadelphia, Pa.
New Britain Mach. Co., New Britain, Conn.

Gas Blowers and Exhausters

Sturtevant Co., B. F., Boston, Mass.

Gages, Recording

Bristol Co., Waterbury, Conn.

Gages, Standard

Brown & Sharpe Mfg. Co., Providence, R. I.
Henry & Wright Mfg. Co., Hartford, Conn.
Mass. Tool Co., Greenfield, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, Jno. M., Gloucester City, N. J.
Slocomb Co., J. T., Prov., R. I.
Starrett Co., L. S., Athol, Mass.

Gages, Steam

Lunkenheimer Co., Cincinnati, O.

Gear Cutting Machinery

Adams Co., Dubuque, Iowa.
American Watch Tool Co., Waltham, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Bickford Drill & Tool Co., Cin., O.
Brown & Sharpe Mfg Co., Providence, R. I.
Clough, R. M., Tolland, Conn.
Eberhardt Bros. Mach. Co., Newark, N. J.

Gear Cutting Machinery —*Continued.*

Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sloane & Chace Mfg. Co., Newark, N. J.
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery

Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut

Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Eickemeyer Mfg. Co., Yonkers, N. Y.
Fawcus Mch. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, O.
Massey Mach. Co., Watertown, N. Y.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Syracuse Raw Hide Mfg. Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Molded

Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Wks., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

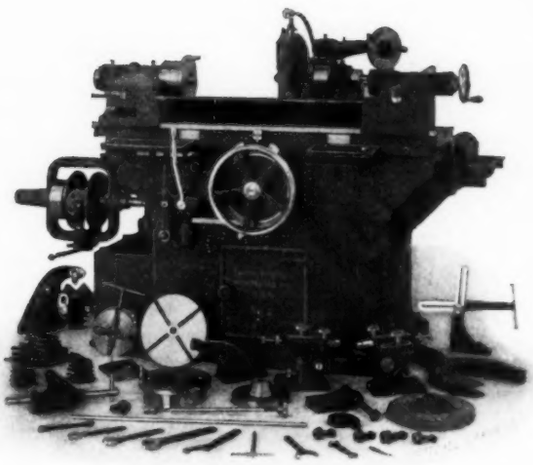
Gears, Rawhide

Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Syracuse Raw Hide Co., Syracuse, N. Y.

Gears, Worm

Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
VanDorn & Dutton, Cleveland, O
Walcott & Son, Geo. D., Jackson Mich.

Landis No. 2 Universal with Automatic Feeds



12 Inch Swing. 32 Inches Between Centers.

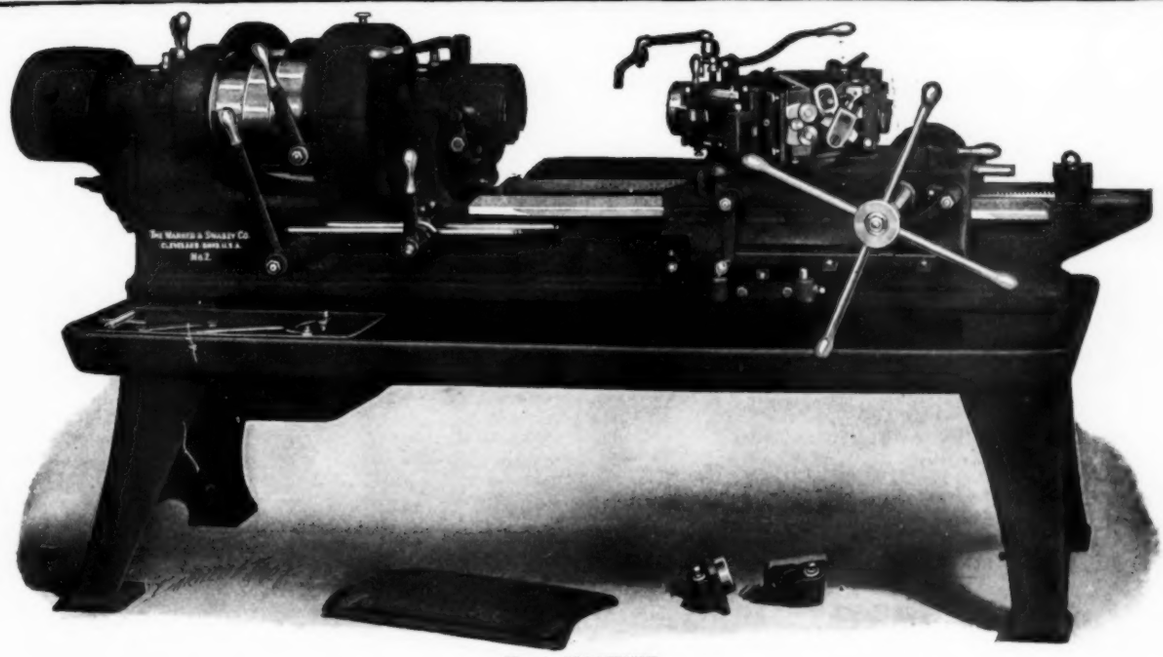
is an indispensable tool for grinding and regrinding spiral—solid and inserted tooth surface mills. As regularly equipped it has no near competitor for grinding spindle shafts—straight and taper, sides of saws, plates and all work that can be carried by a face plate or chuck—internal or external.

For tool room work it is also a good one. By the use of special attachments a great variety of additional grinding operations can be performed, which includes every operation of grinding such parts as straight and taper reamers.

If this doesn't happen to be the machine you require, ask about the other Landis types, of which there are a large variety.

Landis Tool Company, Waynesboro, Pa., U. S. A.

AGENTS—W. E. Flanders, 309 Schofield Building, Cleveland, Ohio, and 933 Monadnock Blk, Chicago, Ill. Walter H. Foster Co., 114 Liberty St., New York. C. W. Burton, Griffiths & Co., London. Schuchardt & Schutte, Berlin, Vienna, Stockholm, St. Petersburg. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan and Bilbao. A. R. Williams Machinery Co., Toronto. Williams & Wilson, Montreal, Can.



No. 2 MACHINE.

Hollow Hexagon Turret Lathes

THREE SIZES:

No. 1—1⅜ x 15, No. 2—2¼ x 24, No. 3—3⅜ x 36"

FOR RAPID PRODUCTION

THE WARNER & SWASEY CO.

CLEVELAND, OHIO, U.S.A.

TURRET LATHES SCREW MACHINES
BRASS WORKING TOOLS

FOREIGN AGENTS: Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. Schuchardt & Schutte, Berlin, Vienna, St. Petersburg and Glasgow. Alfred H. Schutte, Cologne, Paris, Brussels and Milan. H. W. Petrie, Toronto. Williams & Wilson, Montreal.

Generating Sets

Crocker-Wheeler Co., Ampere, N. J.
General Electric Co., New York.
Ridgway Dynamo & Engine Co., Ridgway, Pa.
Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Boston, Mass.
Triumph Elec. Co., Cincinnati, O.
VanDorn & Dutton, Cleveland, Ohio.
Walcott & Son, Geo. D., Jackson, Mich.

Generators, Gas

American Gas Furnace Co., New York.

Gibs

Standard Gauge Steel Co., Beaver Falls, Pa.

Graphite

Dixon Crucible Co., Jos., Jersey City, N. J.
Obermayer Co., S. Cincinnati, O.

Grinders, Automatic Knife

Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.

Grinders, Center

Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mch. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Rivett-Dock Co, Boston, Mass.

Grinders, Cock

Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter

Bath Grinder Co., Fitchburg, Mass.
Becker-Brainard Milling Mach. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Dayton Machine & Tool Works, Dayton, O.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., New York.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Cylindrical

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Heald Mach. Co., The, Worcester, Mass.
Norton Grinding Co., Worcester, Mass.

Grinders, Disk

Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Diamond Mach. Co., Prov., R. I.
Gardner Machine Co., Beloit, Wis.
Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Iroquois Mach. Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

Grinders, Drill

Heald Mch. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

Grinders, Internal

Bath Grinder Co., Fitchburg, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mch. Co., Worcester, Mass.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Piston Ring

Heald Mach. Co., Worcester, Mass.

Grinders, Portable

Cincinnati Electrical Tool Co., Cincinnati, O.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.

Grinders, Tool

Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Grinding and Polishing Machines

Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Coates Clipper Co., Worcester, Mass.
Crocker-Wheeler Co., Ampere, N. J.
Diamond Mach. Co., Prov., R. I.
Fairbanks Co., New York.
Goodell-Pratt Co., Greenfield, Mass.
Greenfield Mach. Co., Greenfield, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Machine Co., Cin., O.
Iroquois Mach. Co., New York.
Landis Tool Co., Waynesboro, Pa.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Elec. Mfg. Co., Madison, Wis.
Norton Emery Wheel Co., Worcester, Mass.
Norton Grinding Co., Worcester, Mass.
Prentiss Tool & Supply Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett-Dock Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Royersford Fdry. & Machine Co., Royersford, Pa.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.

Grinding and Polishing Machines —*Continued.*

Vandyck Churchill Co., New York.
Vitrified Wheel Co., Westfield, Mass.
Webster & Perks Tool Co., Springfield, O.
Wells & Sons Co., F. E., Greenfield, Mass.

Grinding Wheels

Abrasive Material Co., Philadelphia, Pa.
Adams Co., Dubuque, Iowa.
Builders' Iron Foundry, Providence, R. I.
Carborundum Co., Niagara Falls, N. Y.
Diamond Mach. Co., Prov., R. I.
Hampden Cor. Wheel Co., Brightwood, Mass.
National Corundum Wheel Co., Buffalo, N. Y.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, N. Y.
Safety Emery Wheel Co., Springfield, O.
Vitrified Wheel Co., Westfield, Mass.
Whitney Mfg. Co., Hartford, Ct.

Grindstones and Frames

Niles-Bement-Pond Co., New York.

Gun Barrel Machinery

Diamond Mach. Co., Prov., R. I.
Pratt & Whitney Co., Hartford, Conn.

Hammers, Drop

Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Gould & Eberhardt, Newark, N. J.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Hammers, Pneumatic

Cleveland Pneu. Tool Co., Cleveland, O.
Dayton Pneumatic Tool Co., Dayton, Ohio
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Hammers, Power

Fairbanks Co., New York.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Scranton & Co., The, New Haven, Conn.

Hammers, Steam

Bethlehem Fdry. & Mach Co., So. Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Crescent Forgings Co., Oakmont, Pa.
Marshall & Huschart Machinery Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

Handles, Machine Tool

Whitman & Barnes Mfg. Co., Chicago, Ill.

Handles, Screw Plate

Standard Welding Co., Cleve., O.

Hangers, Shafting

Cresson Co., Geo. V., Phila., Pa.
Fairbanks Co., New York.
Hyatt Roller Bearing Co., Harrison, N. J.
Link-Belt Engineering Co., Philadelphia, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.

Heaters, Feed Water

Sturtevant Co., B. F., Hyde Park, Mass.

Heating and Ventilating Apparatus

Buffalo Forge Co., Buffalo, N. Y.
Sturtevant Co., B. F., Hyde Park, Mass.

Heating Machines

Am. Gas Furnace Co, New York.
Chicago Flexible Shaft Co., Chicago, Ill.

Hoisting and Conveying Machinery

Alliance Machine Co., Alliance, Ohio.
Brown Hoisting Mchry. Co., Cleveland, O.
Caldwell & Son Co., H. W., Chicago, Ill.
Cleveland Crane & Car Co., Wickliffe, O.
Cresson Co., Geo. V., Phila., Pa.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Engineering Co., Philadelphia, Pa.
Main Belting Co., Phila., Pa.
Nicholls, Wm. S., New York.
Niles-Bement-Pond Co., New York.
United Engineering & Fdry. Co., Pittsburg, Pa.

Hoists, Electric

C & C Electric Co., New York.
Cleveland Crane & Car Co., Wickliffe, O.
Crocker-Wheeler Co., Ampere, N. J.
Curtis & Co., Mfg. Co., St. Louis, Mo.
Frevert Mfg. Co., New York.
General Electric Co., New York.
General Pneu. Tool Co., Montour Falls, N. Y.
Maris Bros., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Co., New York.
Yale & Towne Mfg. Co., New York.

Hoists, Hand

Case Manufacturing Co., Columbus, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa
Moore Co., Franklin, Winsted, Conn.
Yale & Towne Mfg. Co., New York.

Hoists, Pneumatic

Cleveland Pneu. Tool Co., Cleveland, O.
Curtis & Co. Mfg. Co., St. Louis, Mo.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Nicholls, Wm. S., New York.
Northern Engineering Works, Detroit, Mich.

Hose, Steel

Sprague Elec. Co., New York.

Igniters, Gas Engine

Franklin Mfg. Co., Syracuse, N. Y.
Goodson Electric Ignition Co., Providence, R. I.

Indicators, Speed

Norton Emery Wheel Co., Worcester, Mass.
Starrett Co., L. S., Athol, Mass.

Indicators, Speed, Peripheral

Warner Instrument Co., Beloit, Wis.

Industrial Railways

Hunt Co., C. W., West New Brighton, N. Y.

Injectors

Desmond-Stephan Mfg. Co., Urbana, O.
International Specialty Co., Detroit, Mich.
Lunkenheimer Co., Cincinnati, O.
Sellers & Co., Wm, Phila., Pa.

Inspection and Tests

Hunt Co., Robt. W., Chicago, Ill.

Instruction Schools

See Schools Correspondence.

Instruments, Electric

General Eleceric Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.

Insurance, Boiler

Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.

Iron Filler

Clark Cast Steel Cement Co., Shelton, Conn.

Jacks, Hydraulic

Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Watson-Stillman Co., New York.

Jacks, Planer

Armstrong Bros. Tool Co., Chicago, Ill.

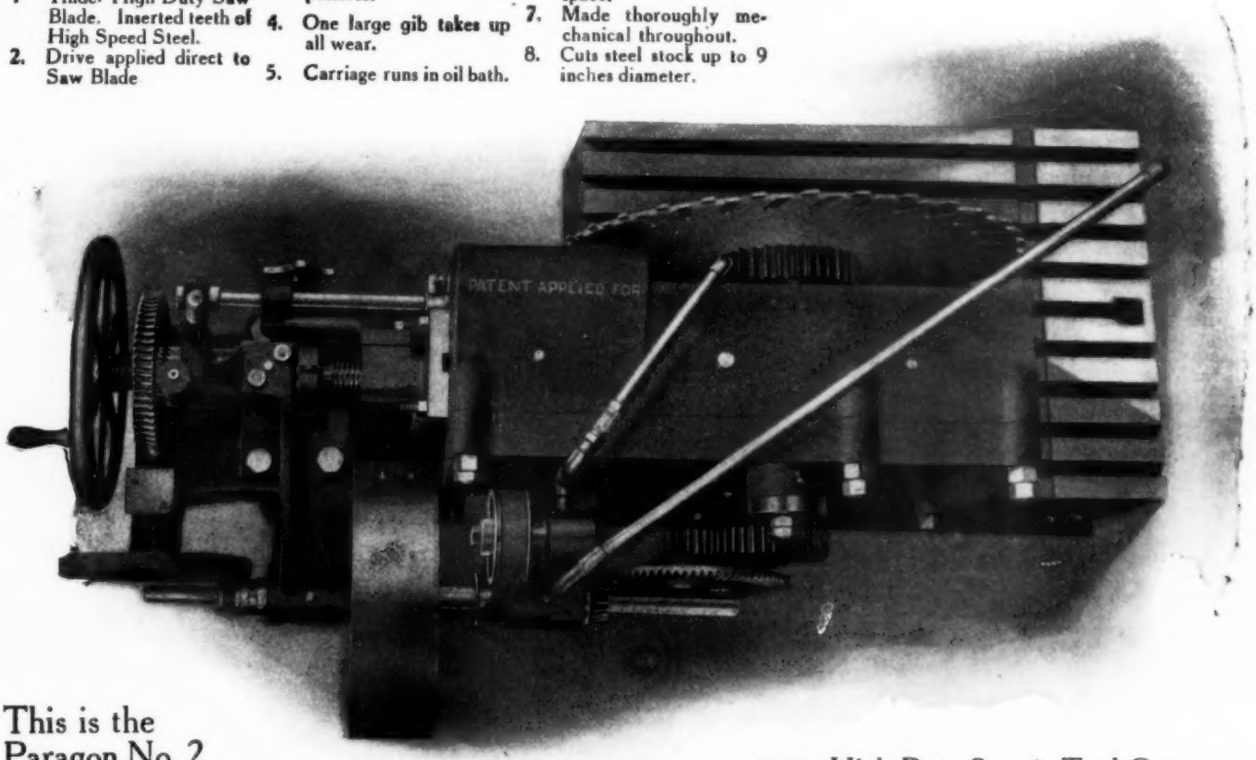
Kettles, Soda

Mfg. Equip. & Engrg. Co., E. Boston, Mass.

THE TINDEL HIGH DUTY SAWING MACHINES

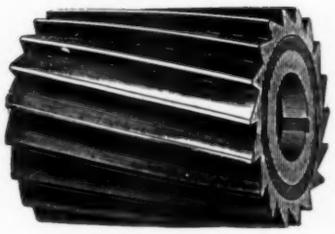
Features for High Duty:

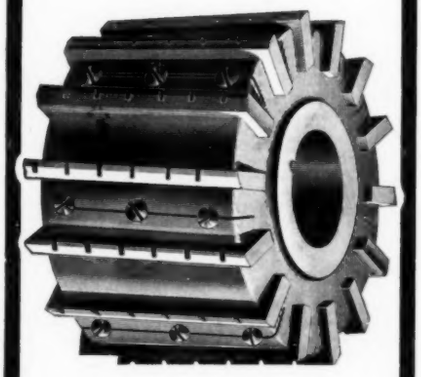
1. Tindel High Duty Saw Blade. Inserted teeth of High Speed Steel.
2. Drive applied direct to Saw Blade
3. Draw cut. No buckling possible.
4. One large gib takes up all wear.
5. Carriage runs in oil bath.
6. Great power in small space.
7. Made thoroughly mechanical throughout.
8. Cuts steel stock up to 9 inches diameter.



This is the Paragon No. 2.

Made by High Duty Saw & Tool Company
EDDYSTONE, PENNA.





We are always pleased to know that our Cutters are to be placed in competition—where their life and accuracy may be determined.

A long experience in Cutter making—a finely equipped shop—and our attention given to Cutters only is a sufficient statement for the mechanic.

A guarantee of quality and workmanship.

Union Twist Drill Company

Makers of Cutters **Athol, Mass.**

Successors to GAY & WARD.

New York Store,
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Boston Agents,
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E. T. Ward & Sons.

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52 North 5th St.
Field & Co., Agents.

Chicago Store
68-70 South Canal St.
H. E. Barton, Mgr.

London Agents,
112 Queen Victoria St.
Chas. Neat & Co.

Key Seaters

Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
Chattanooga Mchry. Co., Chattanooga, Tenn.
Lapointe Machine Tool Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Whitney Mfg. Co., Hartford, Ct.

Keys, Machine

Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Ct.

Knives, Shear

Phillips & Sons Co., F. R, Philadelphia, Pa.

Knurls

Hammacher, Schlemmer & Co., New York.

Lamps, Arc

General Electric Co., N. Y. City.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lamps, Incandescent

General Electrical Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Lathe Attachments

American Tool Wks. Co., Cin., O.
Bradford Machine Tool Co., Cincinnati, O.
Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Rivett-Dock Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Sloane & Chace Mfg. Co., Newark, N. J.

Lathe Dogs

Armstrong Bros. Tool Co, Chicago, Ill.
Besly & Co., Chas. H., Chicago, Ill.
Le Count, Wm. G., So. Norwalk, Conn.
Pratt & Whitney Co., Hartford, Conn.
Tindel-Morris Co., Eddystone, Pa.

Lathes

American Tool Works Co., Cin., O.
Automatic Mach. Co., Bridgeport, Conn.
Barker & Co., Wm., Cincinnati, Ohio.
Barnes Co., W. F. & John, Rockford, Ill.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Blount Co., J. G., Everett, Mass.
Bradford Mach. Tool Co., Cin., O.
Bullard Mach. Tool Co., Bridgeport, Conn.
Davis Machine Co., W. P., Rochester, N. Y.
Detrick & Harvey Mach. Co., Baltimore, Md.
Diamond Mach. Tool Co., Prov., R. I.
Dreses Mach. Tool Co., Cincinnati, O.
Fairbanks Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gisholt Machine Co., Madison, Wis.
Greaves, Klusman & Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mach. Tool Co., Cincinnati, O.
McCabe, J. J., New York.
Marshall & Huschart Mchry. Co., Chicago, Ill.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Robbins, L., Worcester, Mass.
Schumacher & Boye, Cincinnati, Ohio.
Sebastian Lathe Co., Cincin., O.

Lathes—*Continued.*

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Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Springfield Mch. Tool Co., Springfield, O.
Tindel-Morris Co., Eddystone, Pa.
Vandyck Churchill Co., New York.
Von Wyck Mach. Tool Co., Cincinnati, O.
Walcott & Son, Geo D., Jackson, Mich.
Wels & Sons Co., F. E., Greenfield, Mass.
Whitcomb-Blaisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Lathes, Automatic Screw-Threading

Automatic Machine Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Lathes, Bench

American Watch Tool Co., Waltham, Mass.
Blount Co., J. G., Everett, Mass.
Fenn-Sadler Mach. Co., Hartford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett Lathe Mfg. Co., Boston, Mass.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.
Stark Tool Co., Waltham, Mass.
Sloane & Chace Mfg. Co., Newark, N. J.
Waltham Machine Works, Waltham, Mass.
Waltham Watch Tool Co., Springfield, Mass.

Lathes, Boring

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Lathes, Brass

Barker & Co., Wm., Cincinnati, O.
Dreses Mach. Tool Co., Cincin., O.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Springfield Mch. Tool Co., Springfield, O.
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Lathes, Extension

Harrington, Son & Co., Edwin, Philadelphia, Pa.
Prentiss Tool & Supply Co., New York.

Lathes, Foot Power

Barnes Co., W. F. & Jno., Rockford, Ill.
Seneca Falls Mfg. Co., Seneca Falls, N. Y.

Lathes, Speed

Blount Co., J. G., Everett, Mass.

Lathes, Wood

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Seneca Falls Mfg. Co., Seneca Falls, N. Y.

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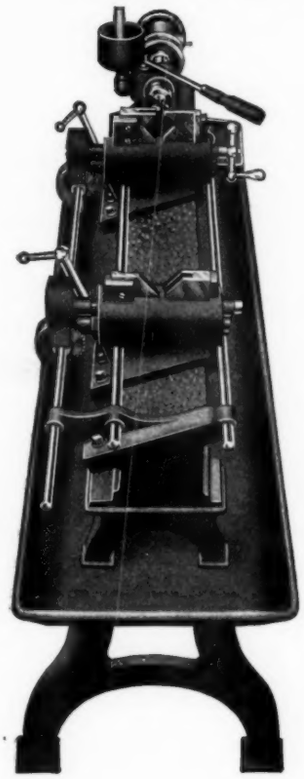

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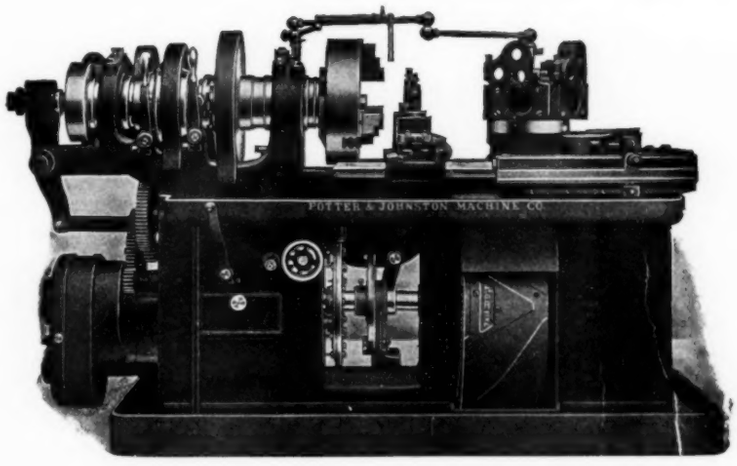

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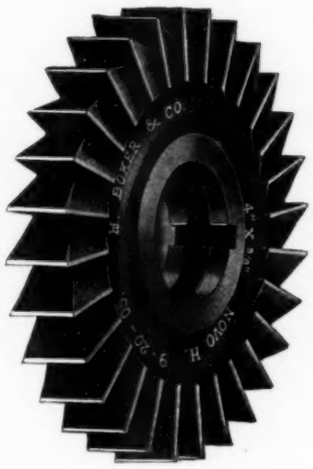

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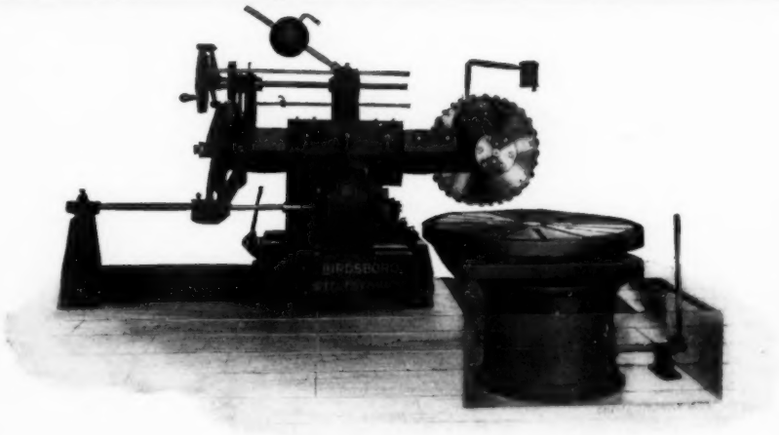

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Wrenches, Universal

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Whitman & Barnes Mfg. Co., Chicago, Ill,

Notes on the Cam Chart.

BY JOHN ROY.

A good many years ago when I was an apprentice, a faithful and patient friend spent hours drumming into my head the mysteries of the cam chart. His methods were in a general way akin to those recently illustrated in the AMERICAN MACHINIST. When I left the employment of this friend, one of the first jobs I fell heir to was to complete the design of a cold header which had been schemed out and almost finished by a very able man, whose death had temporarily put an end to the work. It was a special machine for a special class of work, and nobody about the place was familiar with it, so very naturally the starting point was the cam chart, which I was horrified to find, looked like Fig. 1.

I will not venture to say how much time I put on this chart or how much midnight oil I burned on my own account in raveling this mystery, for such it was to me. I finally managed to reduce it to terms or ideas that I understood, and reconstructed the chart to look like Fig. 2. For awhile after that I was afraid to speak of a cam chart, lest some one would spring a new one on me which would leave me foundering again. Since that time I have been to college, studied text-books and professors, and glanced into many reference books without ever having seen or heard of a published word regarding the construction, use or theory of any kind of cam chart until the appearance of C. F. Smith's excellent articles in Vol. 28, Part 1, of the AMERICAN MACHINIST. I did not agree with him in every particular, but the worth of the paper was so apparent, and so far above anything I could do myself, that I determined not to confuse the readers by objections. However, a man should be pretty careful about what he puts into print, for cold type add a dignity and weight to an *opinion* which too frequently converts it into a *law* to those struggling for information. For this reason I wish he had discussed more at length cam and short systems different from his own (I am sure he has met with many such) and had gone through some process of elimination of the bad or worst ones. I have worked into, evolved, or absorbed a pretty definite method of procedure for the design of cams, yet I was startled the other week to find one of my young men breaking away from precedent and trying to lay out a cam as described in the article referred to, because he considered the said precedent bad and not according to the rules. Hence, in self defense, it seems, I must seek to *print* my ideas in order to keep them.

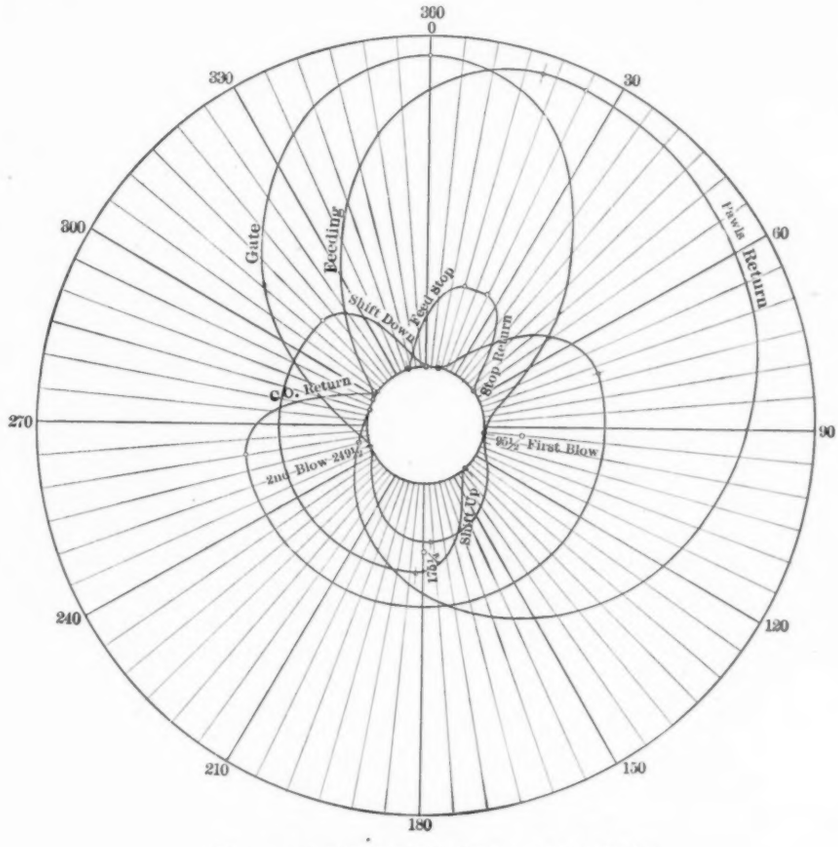


FIG. 1. AN UNDESIRABLE FORM OF CAM CHART.

I will do it categorically in the form of a comparison with Mr. Smith's articles.

1. Laying out the chart with cams overlapping.

I very much prefer to give each cam a separate base line and space all its own, as in Fig. 2. In this way the whole path of motion of any cam is seen at a glance, while to pick out a path from the chart facing page 382 is a job for a novice, and anyone is apt to lose it while hunting for another path to compare with it. In this way the numbering scheme, which was new to me, could be much more clearly carried through. Further, I like to see the motion of the real working point and throw of the cam both dimensioned on the chart, as shown in Figs. 2, 3 and 4. This practice will save a good deal of trouble and turning over of tracings. It will be seen that curve marked *Feed* in Fig. 2 has a separate base line, but cuts through and encroaches on the space reserved for *Stroke* of *Gate*. This is a perfectly legitimate and sometimes very useful exception to the rule. I may as well add at the start that I constantly take liberties with all these, my self-appointed guides, as every one should who is master of his own.

2. Sticking too close to the one machine for a type of cam chart, and thus giving the impression that it must always be elaborate and according to fixed rules.

For example, three weeks were spent on the chart mentioned. It is frequently necessary to have the complete set of drawings in the shop in that time. In designs where cam charts are necessary it rarely happens that more than two or three movements are so related that every point in their course must be known. Especially is this true in designs that are modifications or enlargements of existing types of machines. Mr. Smith states this plainly in the opening paragraph of his first article. For these few the precise accurate path may be plotted on the chart and the remainder and larger number simply represented by straight lines. All that is necessary to know, *i. e.*, where they start and stop, is thus shown. When there are several motions on a machine from 8 to 10 inches in length, it is desirable to scale them down to 2 or 3 inches for sake of clearer representation; in all cases, of course, putting the proper dimensions in place. Figs. 3 and 4 illustrate my meaning in these particulars. In curve, "*Nut Holder Out and In.*" Fig. 3, the only portion plotted accurately is at *A* where it is necessary to know just when the safety must act. The only other curves whose paths it was desirable to know on this machine are shown as plotted curves; other times are indicated perfectly as well, and with less effort and time, by straight lines.

While it is very desirable to keep the cam path down to an angle of 30 degrees or less, it frequently cannot be done, and sometimes on rapid running machinery to increase the diameter of the cam to make

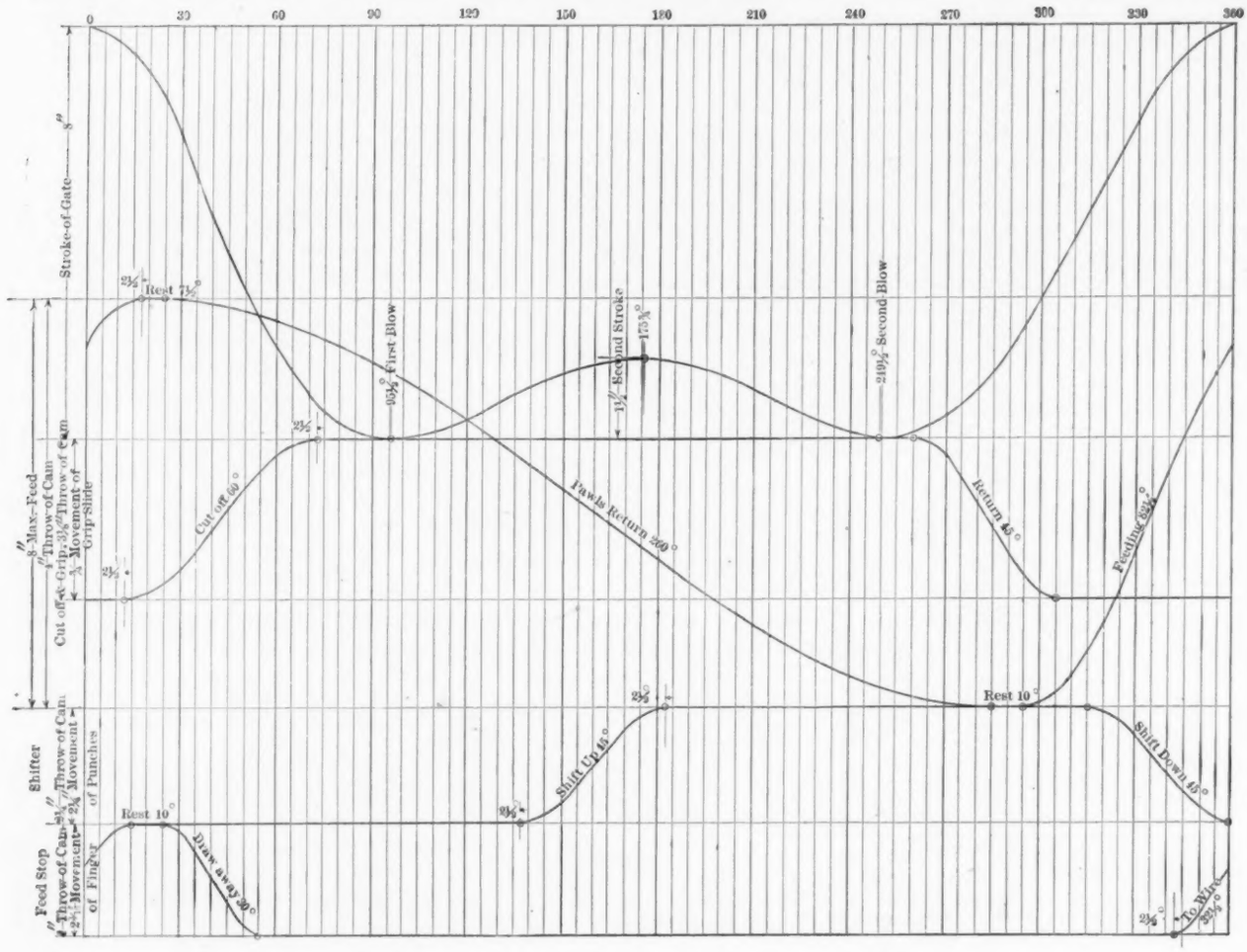


FIG. 2. THE CHART OF FIG. I ARRANGED IN BETTER FORM.

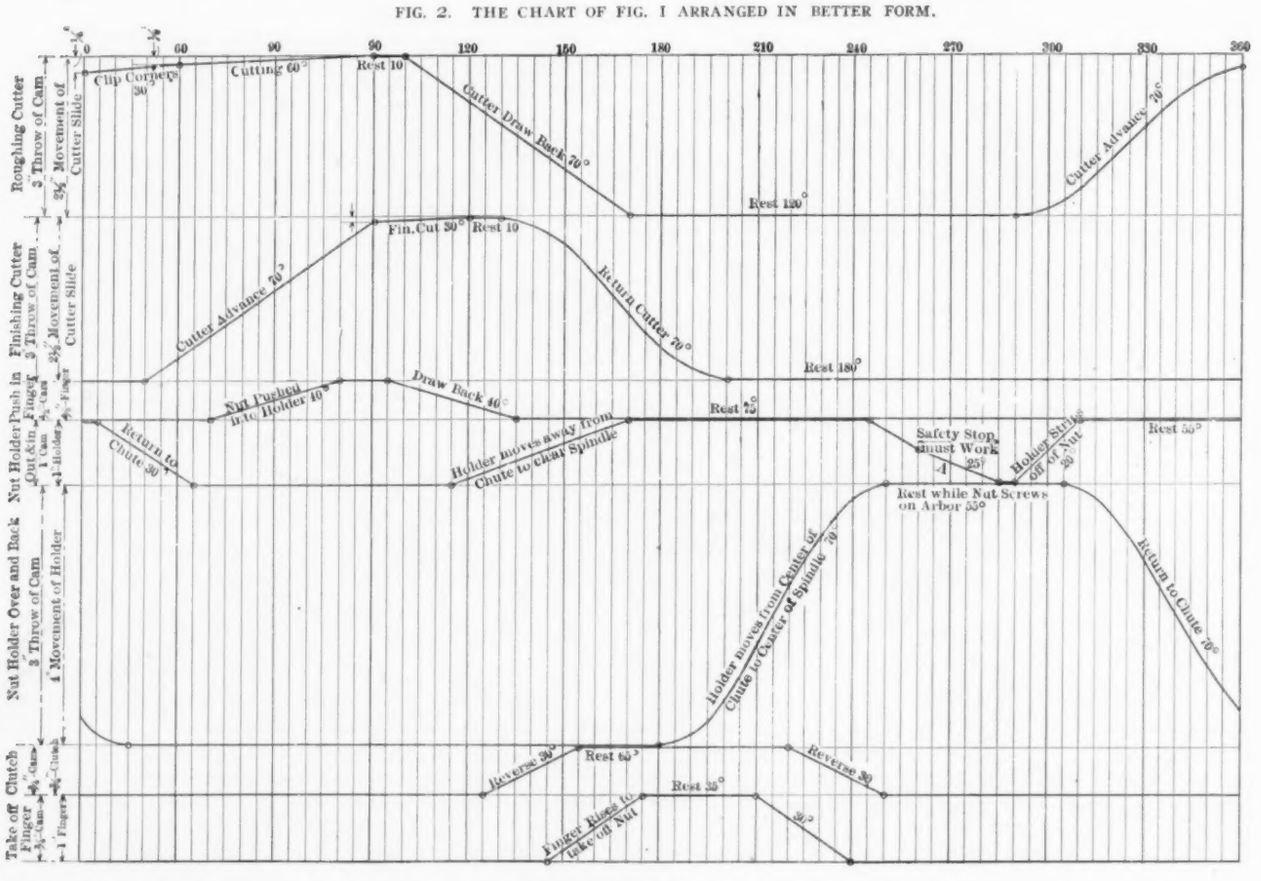


FIG. 3. SAVING LABOR BY USING STRAIGHT LINES.

the path gentler, would lead to more serious troubles. I have seen in use for a good many years reciprocating slide cams with an angle of 60 degrees. The rollers on these start gently, get up to speed and run up a straight 60-degree incline to the top, *i. e.* about ½ inch of the straight face. About 130 reciprocations are made per minute. They work hard, of course, but they work commercially and that is enough.

3. The method of locating keyways is slow, inexpensive and unnecessary.

A great many cams simply have the path cast on and are smoothed up with a file. With these the keyway must be located by means of the chart. Large heavy duty cams, with rolls, say, from 3 inches diameter by 1½ inches face to 6 inches diameter by 3 inches face, are usually made of cast-iron with inserted tool-steel faces where the hard work comes. It is unnecessary to core out for all these, and again the location of the keyway is important. The same is true where the complete cam is made of tool-steel, and which must be forged to shape, for it is too expensive to cut it away. In my own work I frequently meet with cams weighing from 200 to 1,000 pounds, most of them with inserted steel faces and many with gear teeth on the periphery. Manifestly no system of assembling or trying out could be tolerated with these, for either keyway or gear-teeth location. I follow with uniform success the method Mr. Smith describes under "Location of zero of individual cams," page 408. Of course no system of checking this part of the work can be too tedious or laborious if it is accurate. Sometimes, for greater safety, I make paper models of the cam outlines and actually try them in place on the drawing.

To go back to Figs. 3 and 4 for a moment, we have here an excellent example of the value of careful study of the cam

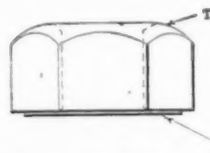


FIG. 5. WORK DONE ON MACHINE CHARTED IN FIGS. 3 AND 4.

chart. Fig. 3 is the chart for a nut-finishing machine which had been running for years, finishing the nut, Fig. 5, where marked *Top*. This operation had some time ago been discontinued, and only the *bottom* was finished in this machine. After careful study it was found possible to do away with the finishing-cutter, trim a little here and there and push all the cams back closer together until the movements were all completed in 180 degrees of movement. From this it was only a step, the form of cams happily permitting, to lay out all the motions on the same cams again and get just double as many finished nuts as formerly—as shown in Fig. 4. It will be seen that neither the cutting-speed nor the feed has been altered. Of course an extra safety stop must be put in to stop the machine when a bad nut comes down.

I have purposely not explained Fig. 1. It is a good problem for those not familiar with the cam chart to work out. I will only state that it represents exactly what Fig. 2 represents, except that the degree lines are arranged in a circle, but it is not to be compared with the other style of chart for simplicity. Those who are curious can work it out and others would not care for an explanation. There is still another style of chart I have met with a good deal. Fig. 1 would illustrate this method if each curve, instead of starting from a common zero, were to start from its own individual actual zero, *i. e.* line of motion. This is a laborious and unwieldy chart, but helpful in locating keyways.

At page 516 Mr. Smith makes a statement that is either misleading or not "far-leading" enough. He is speaking of a yoke working in ways (Fig. 31) and adds, "The yoke may obviously be placed on a radius arm." Of course it is clear enough to him, but I think it important enough to put in black and white, that a yoke on a swinging arm is quite a different thing from a yoke sliding in ways. A yoke like Fig. 31, sliding in ways, can only go back in the same time that it goes forward—a yoke on a swinging arm can never do this.

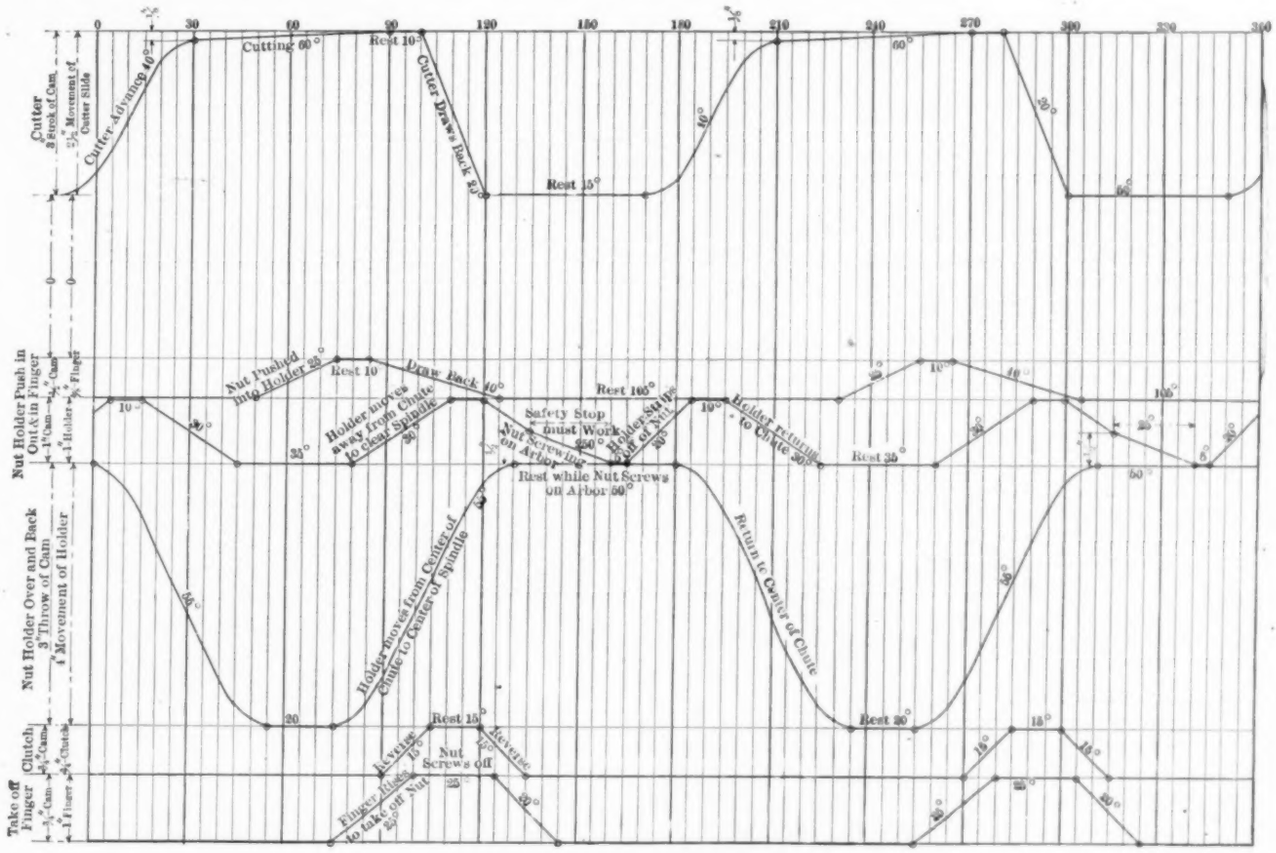


FIG. 4. THE CHART OF FIG. 3 REARRANGED TO DOUBLE THE OUTPUT.

An Opening Taper-Threading Die and a Collapsing Pipe-Tap.

The accompanying half-tones and line engravings illustrate some interesting types of threading devices manufactured by the Geometric Tool Company, of New Haven, Conn.

The first of these, shown by Figs. 1 to 3 inclusive, is a taper-threading die in which is incorporated the opening feature of the regular die made by the same company for cutting parallel threads.

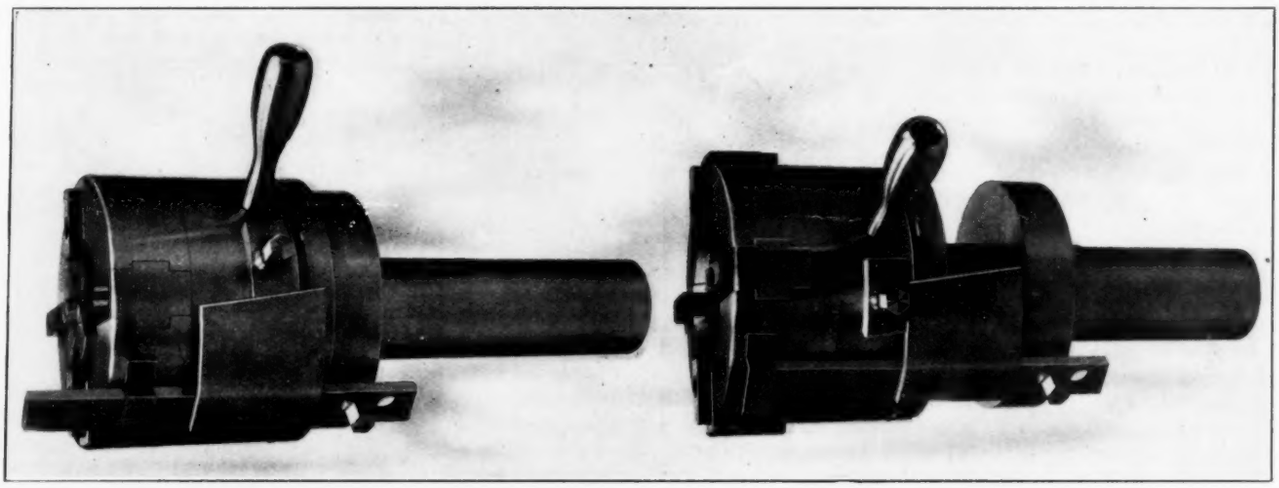


FIG. 1. TAPER-THREADING DIE SET FOR CUTTING.

FIG. 2. TAPER-THREADING DIE OPENED.

As set for cutting, the die is seen in Fig. 1. Fig. 2 represents it opened, as upon the completion of the thread. The construction will be understood from Fig. 3, where *A* is the head and shank, formed integrally; *B* the cam ring for operating the chasers; *C* the taper bar or guide for controlling the movement of the cam ring, and so determining the degree of taper given the thread, both chasers and guide bar being made as desired to suit any required taper per foot.

The face of the cam ring is represented in the detail, and each of the four cam slots shown cut therein is adapted to receive a lug formed on the rear face of chaser carriers *D*; the four chasers and their positions over the cam slots being clearly indicated in the end view of the die head, which shows also, in conjunction with the half-tones, the method of mounting and retaining the chaser carriers in the head. The cam ring is confined endwise by the head proper and the retaining ring *E*, and while it may be rotated within certain limits upon its seat, the spiral spring *F*, which presses against a stop pin in ring *E* and an opposing pin in the cam ring, tends always to turn the cam forward and keeps the shoe *G* in contact with taper bar *C*.

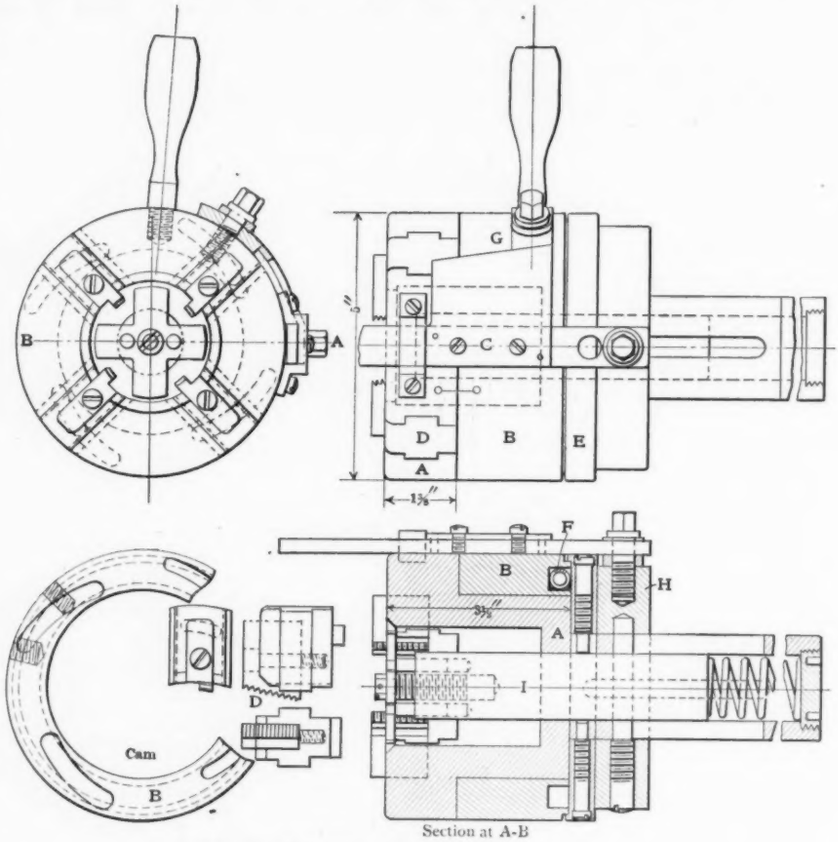


FIG. 3. SHOWING CONSTRUCTION OF DIE.

The bar is supported in a guide at the outer end and at the rear is attached to a collar, *H*, which by means of a stud passing through slots in the walls of the hollow shank, is rigidly connected with plunger *I*. The spring behind the plunger presses the latter forward and as a result the taper bar is normally held in its outermost position as represented in the drawing. When the die is run on the work, however, the end of the piece being threaded comes in contact with a hardened plate attached to the end of the plunger and the taper bar is thus held stationary, while the die continuing forward, steadily opens and cuts the thread to the required taper. When shoe *G* clears the outer corner of the taper bar the cam ring is then no longer controlled by the guiding surface on the bar and the die is thrown open, as in Fig. 2.

The contact plate at the end of plunger *I* and the taper bar admit of endwise adjustment to suit the work in hand, and shoe *G* also is adjustable for setting for threads above or below standard diameters.

The die shown is known as the 2-inch, and will cut threads from 1¼ to 2 inches diameter. The taper bar in this case is for work having a ¾-inch taper per ft. and will answer for threads 2½ inches long. For standard pipe threads, it is usually unnecessary to employ the taper bar as the chasers of the regular opening

die-head are sufficiently deep to cover the thread length required.

In Fig. 4 is illustrated a collapsing pipe tap whose construction and operation are represented clearly in Fig. 5, the latter engraving showing the device in both cutting and collapsed positions and bringing out certain features in detail.

The body of this tool, which is reduced at the rear end to form the shank, is slotted radially at the front to receive the chasers and bored through from end to end for a plunger *K* which controls the chasers and which is itself operated by cam *L* and opposing-spring *M*. The plunger head is provided with a series of inclined ribs which interlock, in the manner indicated, with the chases, and, as is obvious from the detail, any movement of the plunger endwise must necessarily result in positive movement of the chasers radially.

The forward movement of the plunger which is necessary to expand the chasers and so set the tool for tapping, is imparted by the cam *L* which is freely

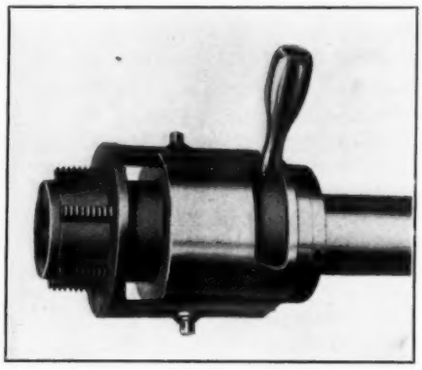


FIG. 4. COLLAPSING PIPE TAP.

mounted on the body of the device, and to the periphery of which an operating handle is secured, this handle passing, as shown, through a circumferential opening formed in the sleeve or casing *N*. When the handle is pushed over to the position indicated in both the half-tone and the upper view in the drawing, the cam acting upon both ends of cross-bar *O*, which passes through the plunger, sets the latter in its extreme forward position with the chasers fully expanded. As the tap runs into the piece threaded and the end of the work comes in contact with plate *P* which is connected to sleeve *N*, the sleeve is pushed back and the cam surface at *Q* acting upon the base of the handle turns the cam ahead slightly or to such a position that the spring *M* can draw the plunger back and collapse the tap, the rearward movement of the plunger and bar *O* of course throwing the cam to the central position as represented in the lower assembly view in Fig. 5.

Plate *P* and sleeve *N* are returned to normal position by spring plungers *R*. The plate may be adjusted to collapse the tap at any required depth of thread, and the graduated nut at the rear of the cam may be set to expand or contract the chasers by any desired amount before tapping operations commence. As will be noticed, the handle may be thrown either way from center in operating the tap; this feature permits two cuts to be taken where desirable, which is quite often the case where a tap is used with chasers for threading straight holes. For such purposes the working face of the cam at the top of the incline may be cut back slightly at two diametrically opposite points so as to give plunger *K* a shorter movement forward than when the cam is turned the other way.

It will be observed that, by making the operating plunger with radiating wings, it is necessary to bore only a small hole through the body of the tool, as the wings or ribs fit the slots milled for the chasers, and thus the chaser blades and plunger ribs are always well supported for practically their entire depth.

The tap forming the subject of the illustrations in Figs. 4 and 5 is the 2½-inch pipe size. A larger size of collapsing tap is shown in Fig. 6, this particular tool being suitable for threads from 4½ to 5½ inches diameter, or for 4-inch to 5-inch standard pipe threads. The chasers in this case are mounted in blocks or carriers very similar to those used in the opening die head.

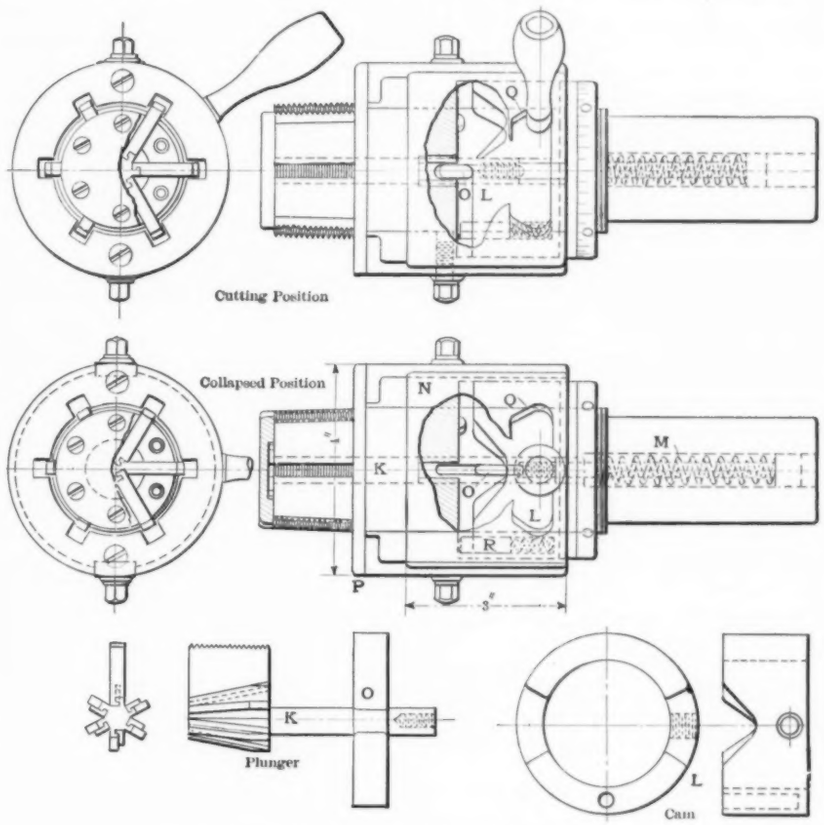


FIG. 5. SHOWING CONSTRUCTION OF COLLAPSING PIPE TAP.

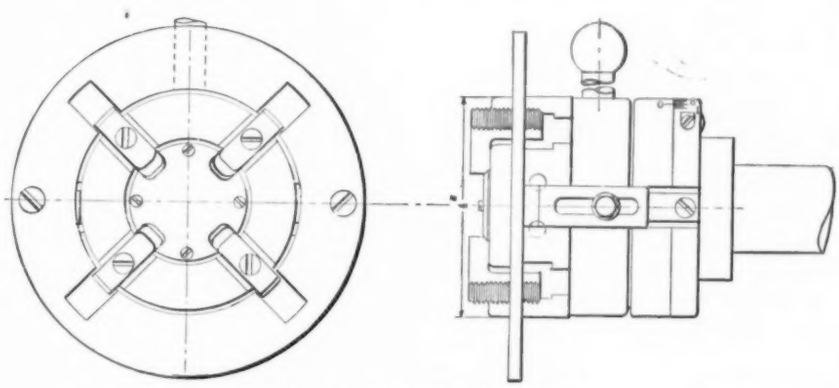


FIG. 6. 5-INCH SPECIAL PIPE TAP.

Unsolved Problems in Electrical Engineering.*

BY COLONEL ROOKES EVELYN BELL CROMPTON, C. B., M. INST. C. E.

The electrical problems which form my subject divide themselves into two groups: those set for us by Nature herself, which chiefly concern the scientific investigator; and those which have presented themselves to us engineers since we began to use electrical energy for man's service. The engineer is only concerned with Nature's problems so far as their investigation comes into his work when he is called upon to provide means to protect our works from damage due to her display of her electrical forces.

PROTECTION FROM LIGHTNING.

The problems of lightning discharges have from the very first interested us, and in these later days of large power schemes the importance of protecting our works against lightning stroke has become increasingly evident. For a long time we thought that the damage caused by lightning was confined to systems of overhead conductors, as its effect on these was at once evident, in some cases by complete destruction of parts of our circuits, in others by the breakdown of our insulation; but during our recent developments of large power schemes, employing systems of conductors to carry the energy into districts where the use of overhead conductors is inadmissible, the influence of lightning discharges, or of earth-strokes connected with them, on our underground systems, has been undoubtedly the cause of many failures and interruptions to service, the investigation of which forms a problem of the first magnitude.

The problem has been insufficiently investigated, but it appears probable that many of the mysterious perforations of the insulation of our underground cables are commenced by static charges due to condenser-effects produced on a gigantic scale in the system.

Closely allied with the investigation of these interesting phenomena are the hitherto unexplained causes of ball-lightning, which appear extremely difficult to understand. We have such consistent accounts, given by truthful and competent observers, of balls of fire moving slowly in the air or rolling along the ground, sometimes attended with slight noise or explosion, in others by violent disruptive effects, that we cannot refuse to believe that ball-lightning is a reality. I am aware that it has been asserted that it does not really exist, but is merely the persistent effect on the retina of the eye produced by a previous brilliant discharge; but as Planté in his researches has distinctly stated that he was able to reproduce ball-lightning effects on a small scale when experimenting with continuous currents of high electromotive force obtained from his accumulators, there can be no doubt that Nature does produce these phenomena for which at present we have no explanation to offer.

Those of us who were at St. Louis last summer witnessed the remarkable luminosity surrounding the electrical conductors carrying currents at the extremely high pressure of 100,000 volts. It appeared under those conditions of electrical stress as if the air itself became luminous, and I suggest that this may throw some light on the phenomena of ball-lightning.

TERRESTRIAL MAGNETISM.

I cannot omit from this lecture mention of the problems of terrestrial magnetism, as they certainly affect electrical engineering works; but our knowledge of the sources of terrestrial magnetism, and of the disturbing influences of what are known as magnetic storms, is so vague, and the hypotheses are based on such scant knowledge, that I am compelled to touch on the matter very lightly. We do not know with any certainty where the magneto-motive force which produces the earth's field originates, that is to say, whether its source is within the earth itself or is situated externally to it. Quite recently it has been definitely shown that the sun has a magnetic field, for the solar corona has a very definite polar structure; but even if we agree that the sun is, like the earth, a gigantic dynamo, the magnetic effects in both cases being possibly due to their rotation on their axes, the magnetic moment of the sun must be far too small to enable it to be of itself the cause of the earth's magnetism.

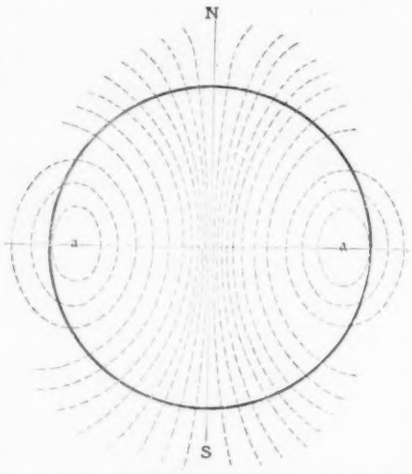


FIG. 1. THE MAGNETIC FIELD OF THE EARTH.

There appear to be three hypotheses of the cause of terrestrial magnetism, namely —(1) that the crust of the earth has at some time, probably shortly after solidification, become a permanent magnet, owing to the circulation of electric currents which possibly may have been produced by thermal causes; (2) that the cause was originally, and may still be, connected with the earth's rotation, which has gradually accumulated its magnetic field, much as is the case with an ordinary self-exciting dynamo; and (3) that the sun itself is the power-station for the whole solar system, and that each of the planets is merely a distributing station for the energy generated in the sun. It can, however, be shown that the direct magnetic effect of the external field produced by the sun must be small, although we know that changes taking place in the sun are unquestionably associated with the appearance of the magnetic storms which are of such importance to the navigator and the telegraphist.

The problem is undoubtedly unsolved, but great light may be thrown on it if the magnetic surveys of the inhabited portions of the globe, and especially those near the Polar regions, can be completed. The diagram (Fig. 1) shows that if we consider the earth as a magnet with North and South Poles, the magnetic lines of force through the equatorial zone of the earth must be directed toward the poles and must curve back from the polar areas to complete their magnetic circuit across the equator; but we have reason to believe that the earth's magnetic field is not symmetrical and differs widely from that shown in the diagram.

TRANSMISSION OF POWER WITHOUT WIRES.

Another problem which is only now commencing to pass outside the domain of the physicist into that of the engineer is that of the etheric transmission of power. The development of electric wave telegraphy is an excellent instance of the various stages of the solving of an electrical problem. In this case Maxwell and Hertz settled the first stage and formulated the laws of the transmission of etheric waves. Branley supplied an important element when he invented the coherer. Marconi's enthusiasm, skill and perseverance, aided by Fleming and other numerous competent co-workers, have carried the third stage to its present development.

We may consider that the etheric transmission of signals up to a given distance, and notably for the purposes of signaling to and between ships at sea, is practically solved, although there are many secondary problems arising out of it. No doubt the first and most important of these is the production of wave-trains sufficiently powerful and of the right character to yield the best results. Fleming has particularly devoted himself to this subject, and the value of his inventions has been fully acknowledged by Marconi.

Taking the economical question first, it has been shown by Fleming that in all probability the method at which we have at present arrived, of communicating waves to the ether by the oscillating discharge of condensers, only utilizes about 1 per cent. of the time available; in fact, that we only have a series of intermittent waves with long vacant spaces intervening. What we require is a better method of originating a continuous train of

*Abridged from the "James Forrest Lecture" delivered at the (English) Institution of Civil Engineers, 1905.

waves rather than these intermittent ones. and here we can formulate our problem, which may be solved by the mechanical engineer, or probably by the electro-chemical engineer. None of us have as yet succeeded in constructing an alternator with a frequency approaching 1,000,000 per second; but who can say that recent developments in extremely high-speed turbo-generators of the De Laval type may not furnish us with a good start in obtaining such frequency by mechanical means? Again, turning to the possibilities within reach of the electro-chemist, very promising attempts have already been made by Lodge and others to produce electrical oscillations from condensers charged by a Cooper-Hewitt mercury-vapor lamp. Duddell has shown by his investigation of the singing arc that herein lies a method of producing a continuous series of discharges, although in this case the frequency obtained is not sufficient for our purpose. At any rate, the solution of this problem of continuous operation by means of Hertzian waves appears to be extremely hopeful, and at any rate it is one of first importance.

One problem connected with electric-wave telegraphy requires mention, although I believe it has been already nearly, if not completely, solved by Fleming. I refer to the noise caused by the signaling spark used in wireless telegraphy especially on board ship. The loud cracking discharge of this spark has the two-fold disadvantage of being a nuisance to anyone in the neighborhood of the apparatus and of entirely defeating secrecy, as the message can be read by anyone conversant with the Morse alphabet. Fleming has caused the discharge to be produced in cast-iron vessels filled with nitrogen or carbonic acid under pressure, and by this means has practically succeeded in silencing the spark, even when large powers are employed.

As to the etheric transmission of power on a large scale, as foreshadowed by Tesla, it is difficult to speak with any certainty or even hopefulness. It is evident that the consequences which would follow on the etheric transmission of considerable amounts of power would be so startling, from every point of view, that they would revolutionize our ideas socially and politically, and would profoundly affect all our present conditions of life.

THE SECOND GROUP OF PROBLEMS.

I now come to the second group of problems connected with the development of electrical machinery in the form that it is now taking, and with which I have personally been most in contact during the past 25 years. It is 30 years since we were introduced to the dynamo. We owe to Faraday, Paccinotti, Varley, Wheatstone and Siemens the early stages of dynamo development. To those who produced our present materials, the permeable iron and steel we use for our magnet-cores, the electrolytic copper we use for our conductors, we owe the second stage. We have since passed through a long series of developments of design, at first determined experimentally, and afterward modified by practical use. The progress of our design has been marked by constant alteration following on new discoveries of systems of generating and utilizing electrical energy; but throughout the considerable changes of the many systems that have been tested, and which still survive, I find that underlying the whole of our progress up to the present we meet with the one main group of problems which forms the central feature of all our designs, namely that relating to the design and construction of the most efficient magnetic field, and which for convenience I hereafter call the problem of "core and coil."

The electro-magnet bears the same relation to electrical machinery that the cylinder, piston and crank bear to the steam engine. Wherever we wish to translate the mechanical into electrical energy, or electrical back into mechanical energy, we are compelled to use the "core and coil," and I hope you will bear with me if I spend some of our time in discussing how much we may yet develop our future knowledge of this important matter.

THE CONSTRUCTION OF MAGNET-CORES.

Take the core first. Although in a few instances, in fact, only for measuring purpuposes, we use coreless electro-magnetic devices, in most cases we find it necessary that a considerable part of the path of the magnetic field should lie within the metal which possesses the highest permeability for magnetic lines of force. This, up to the present, has confined us to iron in its purest form, which, when cast or produced by methods requiring it to be at one time in a molten condition, the engineers have preferred to call steel. In the early days of Faraday and those who followed him it was observed that the best results were obtained when pure forge iron, such as that obtained from Swedish bars, was used for our magnet-cores; but later on, in order to cheapen and facilitate construction, we commenced using cores which could be cast into the desired form. So long as these were of cast iron the permeability was low and the results were therefore poor. Later on, the steel founder was able to make for us castings of high permeability; but when we began to develop the use of alternating-current machinery, or whenever the cores were subjected to alternating electrical stresses, we met with the difficulty that eddy currents were set up within the cores, followed by heating, and in addition we observed for the first time the losses due to hysteresis. When we first formulated our requirements for core-material they were exceedingly simple. We only stipulated that it must be permeable, easily cast, forged or worked into the shapes in which we required to use it, of sufficient mechanical strength, and easily cut or shaped by machine tools. These requirements were easily met by the addition of small percentages of nickel and aluminum, as the use of these alloys produced cores having extreme permeability; but when, as I have just mentioned, it became of extreme importance to minimize eddy currents, we found it necessary to subdivide our cores mechanically, either by slotting or sawing the solid castings or by forming our magnet arms of thin wrought-iron plates, held in position by being cast into cast-iron or cast-steel yokes. But at this stage we encountered an annoying difficulty, which still exists and has been the cause of much disappointment and loss to steel founders and dynamo builders. I refer to the difficulty in producing steel castings for magnets, yokes and frames sufficiently free from blow-holes or porosity to ensure that the magnet-core portions are of equal density of mass and therefore of approximately equal magnetic moment.

This porosity of steel castings will continue to exist so long as they are poured from steel or ingot-iron comparatively free from carbon, silicon and other materials which are present in cast iron, and thereby lower its melting point. The purer material is so viscous that it does not run freely into our molds, and consequently entraps the gases to form the blow-holes and irregularity of mass that I complain of. This difficulty is a real one and may possibly be met by further development of Barrett's discovery that the addition of silicon to cast iron, in suitable proportions, not only renders the whole very fusible, so that complicated and difficult castings free from porosity can be made from it, but also, as he has shown, secures a great gain by reducing hysteresis. It is probable that the silicon acts by reducing the combined carbon that is in the iron in the form of carbide, so that the pure iron is left with a structural formation calculated to give high permeability, as it will be in the form of a sponge or network which will give great freedom for molecular movement. At first sight we might think that such pure iron would have the disadvantage of reducing resistivity, which would facilitate the formation of eddy currents; but in practice this is not so, as, although the iron has lessened resistivity, the cross-sections of the filaments of the pure iron sponge are small, and therefore the mass as a whole offers considerable resistance to those eddy currents. Barrett's discoveries therefore point in the direction from which we may hope to obtain considerable improvement in our magnet-cores. We may therefore re-formulate our requirements for these cores as follows:—Maximum of homogeneity, permeability, low hysteresis coefficient, high resistance as a mass to eddy currents; of course all this combined with sufficient mechanical strength to resist the mechanical stresses due to centrifugal forces when the core forms part of the revolving mass, or to

the stresses set up by magnetic attraction when they form part of the frame of a stator or magnetic ring of large dimensions. In the other class of cores, particularly those subjected to alternating electrical stresses, such as the cores of transformers, we cannot hope to obtain sufficient freedom from the losses due to eddy-currents by other means than minute subdivision, that is to say by lamination, or in some cases by forming the cores of a bundle of individual wires. Great progress has been made in the production of such laminated material, and a great part of our constructive work lies in the organization of the labor necessary to fit together the large number of sheets or stampings which go to form this class of cores.

A PROBLEM FOR THE MACHINIST.

Where such cores are used for revolving armatures we meet with the secondary problem of securing satisfactory balance of the rotating mass, and it is not easy to obtain this, as any turning or cutting process applied to the edges of the thin sheets has a tendency to bring them into electrical conducting contact at the edges and ends, thus giving rise to eddy currents. The same difficulties occur in smoothing out the tunnels or slots of our armatures, and a satisfactory means of effecting this cheaply and efficiently has yet to be found.

Time will not permit of my discussing this great core question as fully as I could wish, but I cannot leave it without referring to the interesting discoveries by Dr. Heusler of magnetic non-iron alloys. Mr. Hadfield has produced for Dr. Fleming rings formed of an alloy of aluminum, copper and manganese which is nearly as magnetic as a low grade of cast iron, although it contains no iron at all. It is possible that the whole secret of magnetism is locked up in these rings; at any rate, the discovery is of extreme importance and may have far-reaching influences on the question of cores.

COILS FOR MAGNETS.

From the first we found that the most convenient method of forming our existing coil or helix was by winding up into a coil on the core itself, or on a separate frame slipped on to it, copper wire of circular cross-section and covered with a fibrous insulating material such as cotton or silk thread. This method of coil-winding has held up to the present date, chiefly on account of its convenience and of the very perfect and economical methods of covering the wire with silk and cotton thread, or in some cases with spiral paper strip, which have been from time to time introduced; but in all these cases the mass of the wound coil is largely made up of insulating material, as on account of the circular section of the copper itself there is much wasted space. Moreover, on account of the low heat-conductivity of the mass of insulation and of the waste air-spaces, the heat-conducting capacity of the coil as a whole is very low. Experiments recently carried out for the Standards Committee by the National Physical Laboratory have shown very clearly that with coils of this class the temperature at the hottest part of the coil is frequently 35° and occasionally 45° F. in excess of its mean temperature, and as in this case the maximum temperature of the coil is the governing factor it is evident that if we can so increase the heat-conductivity as to reduce materially this difference between the maximum and mean temperatures we can improve the coil both in the cost of its production and in its economical working.

I have prepared a diagram (Fig. 2) showing winding in three forms. The first (Case I) shows the relation of copper to insulation and wasted space when cylindrical cotton- or paper-covered wires are wound on short formers provided with flanges of the full depth of the winding. The second (Case II), also a usual form, allows of a more solidly wound coil, the ends of the winding being stepped back so that alternate layers to some extent fit in to the depressions of the adjacent layers. But for the third case I have shown an ideal winding of a coil to produce the same results as to the required magnetic field, and to give sufficient cooling surface to get rid of the heat, but using less copper and having greater heat-conductivity, owing to the continuity of the copper from the inside to the outside of the coil. This ideal winding, you will see, consists of thin copper strip wound on its edge into correct position by suitable machinery, each turn being insulated from the adjacent turn by a thin film of insulating material applied to it at the time it is being wound.

ANOTHER MECHANICAL PROBLEM.

This ideal form of coil-winding has already been occasionally used in practice for the larger coils required for certain transformers and for the magnets of large generators and motors, and it will be seen that we gain greatly in reducing bulk of the winding, weight and cost of copper, and as the magnet-arms are shorter we gain greatly in the size and cost of the framework of the machine; but in order to apply it generally to the smaller class of apparatus we still require a combination of rolling, winding and insulating machinery which will take the rough copper strip and at one operation reduce it to the correct cross-section, wind it into place and apply the coating of insulating material. In my diagram I have not taken advantage of the reduced thickness of insulating material, although I might have done so; but even as shown the reduction in size, weight and cost are very noteworthy. And it is the constructional problem which I here set and formulate for your consideration.

We now come to insulating problems. As I have already said, up to the present we have been content with the older method of fibrous insulation, sometimes untreated, but in other cases impregnated with an insulating varnish or enamel. In order to render our coils non-hygroscopic, so that we can maintain sufficient insulation in a moist atmosphere, we have already introduced vacuum machinery to remove the moisture after they are wound, and afterward we inject our waterproofing and insulating varnishes under pressure to fill up as far as possible the interstices, at all events in the outer layers of winding; at the same time we slightly increase the heat-conducting qualities of the coil as a mass. But, unfortunately, it is difficult by such impregnation to make the coils waterproof to a satisfactory extent, for the fact that when these coils are at work they are alternately heated and cooled, of itself tends to aid the re-entrance of moisture, at all events in this climate.

Quite recently, in connection with this winding question, another difficulty has been observed by Highfield and others, namely, the formation of ozone, and finally of nitric acid, inside the coils, which has in many cases destroyed the fibrous material used for insulation. All this points to the desirability of dispensing with fibrous material and of replacing it by an insulating material which will have sufficient dielectric strength, will stand the action of nitric acid and will increase heat-conductivity. A good deal has been done recently in this direction, and notable advances have been made toward increasing the temperature up to which such insulating compounds can be worked without notable decrease of their dielectric strength; so that, although a few years ago we considered a temperature of 100° C. or 212° F. as quite the highest temperature at which coils could be satisfactorily worked for lengthened periods, we are now slowly coming to the opinion that it is desirable that we should work them at far higher temperatures, and that it is quite reasonable to hope that our chemists will furnish us with suitable insulating materials for impregnation or for coating our conductors which will stand continuously temperatures up to at least 200° C. or 390° F. If we are successful in obtaining the two requirements which I have mentioned, namely, the reduction in the sizes of our coils, as shown in Case III in the diagram (Fig. 2), and the means of working them at higher temperatures without endangering the durability of our plant, we shall benefit greatly, both constructors and users, by reducing the bulk, weight and cost of our machinery without in any way impairing its efficiency.

The recent introduction of high-speed turbo-generators has called attention to the difficulties of designing both the cores and the winding of the revolving fields so that they can successfully withstand the severe mechanical stresses to which they are exposed at these extreme speeds. Much ingenuity has already been exercised in attempting to reconcile the antagonistic requirements of great mechanical strength to resist centrifugal forces

combined with minute subdivision of the core to prevent a free path being given to the eddy currents. It will be seen that here the difficulties of the designer are very great and the problem of overcoming them is yet in its early stages.

ELECTRIC STORAGE BATTERIES.

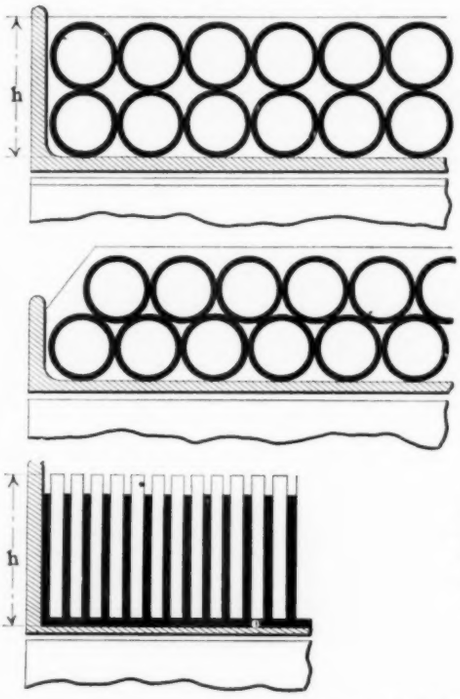
Although we are all agreed that the development of electrical storage is desirable from every point of view, we engineers are still divided into two camps, viz.: those who believe in storage in its present stage of development, and those who hold the contrary opinion that until we have at command a form of electrical storage differing widely from that furnished by the lead-couple accumulator of Planté, we had better leave storage severely alone and trust to careful design and the parallelizing of our generating apparatus, or to similar precautions, for obtaining sufficient regularity of supply to our users.

I have from the first held strongly to the former view, as I have all along considered that in the lead-couple accumulator we have a most valuable means of obtaining sufficient storage for our purposes, and that we had far better address our energies to encouraging the development and improved manufacture of the storage that we have than sit with our hands before us awaiting the invention of something which after all we may never obtain.

It may surprise many of you to hear how great have been the improvements in the lead-couple accumulator during the 15 years or so that it has been in practical use. These developments have been steady and continuous, and have been recently discussed by Mr. Snell in his excellent Paper[1] on electrical distribution; but the fact remains that the accumulator, as we now have it, has taken rank as a part of our electrical plant which is well understood, and from the use of which many of us are obtaining great economical benefit.

The causes of this improvement are twofold. Our early troubles arose partly from difficulties in the manufacture of the plates in the accumulator cells; means were adopted to hasten the formation of these plates during their manufacture, for which we paid somewhat dearly by their shortened life. Another and very important cause of our early troubles was that for a long time we continued to use the cells themselves as a means of regulating our electrical pressures. This introduced conditions extremely unfavorable to the regulating cells of our batteries of accumulators; but since, owing to the discoveries of Chamen, Highfield and others, we have obtained regulation by means of automatic motor-generators, to which the name of "boosters" has been generally given, this difficulty has been largely removed; so that the life of a battery is no longer confined to the short life of its regulating cells, but is that of the whole mass of cells that are all working under the same conditions.

The heavy cost of upkeep of the early accumulators was due to the fact that the active material on which storage capacity depends became detached from the plates and fell to the bottom of the cells in the form of an inert mud, which required to be removed at frequent intervals of time, and was a great source of loss and annoyance.



CASE I

Ampere-Turns	120
Current Density	1
Area of Copper	54.5 Per Cent
Area of Insulation and Space	45.5 Per Cent
Diameter of Wire	100 Mils.=0.1 Inch
Thickness of Insulation	10 Mils.=0.01 Inch

CASE II

Ampere-Turns	120
Current Density	1
Area of Copper	58.6 Per Cent
Area of Insulation and Space	41.4 Per Cent
Diameter of Wire	100 Mils.=0.1 Inch
Thickness of Insulation	10 Mils.=0.01 Inch

CASE III

Ampere-Turns	120
Current Density	1.3
Area of Copper	68.9 Per Cent
Area of Insulation and Space	31.1 Per Cent
Total Space Occupied by Winding	59.34 Per Cent / of that in Case I
Thickness of Insulation	10 Mils.=0.01 Inch

FIG. 2. DIAGRAMS OF MAGNET WINDINGS.

The value of recent improvements may be gaged by the fact that the formation of deposit in the bottom of the cells from this detached active material has been reduced to one-quarter of its quantity during the last five years, and we may safely say that the cost of upkeep of these accumulators has been reduced in the same ratio.

These improvements have been noticed by those who have closely studied this question and have been followed by a great increase in the use of storage, especially where the demand on the electrical energy has been intermittent, or has been confined to short hours, as in towns or villages where the demand up to the present has been principally for domestic purposes during hours when artificial light is required; so that at present my view is that we can design by far the most economical plant for supplying electrical energy for these cases by combining the most economical generating plant that we know of, which is the combination of the internal-combustion engine with a suction gas plant worked for long hours, and thereby charging storage sufficient to deal with the bulk of the load, but supplying the short hours of peak-load from steam-plant specially designed to work for short hours at a maximum efficiency.

A storage problem which has been insufficiently developed, but to which much attention is now being directed, is that of portable storage. We require a box of power, as it was first termed by Lord Kelvin when the Faure accumulator was brought over to this country. After long years of disappointing delay we do see this realized in the very considerable number of private carriages driven by electrical means now in use in the streets of London and Paris.

Here again we have been told that the lead-couple accumulator is hopeless, and that we must wait for something lighter and stronger, such as Edison has been working on for some years past, but again practice has shown that we are far from obtaining anything to take the place of the lead-couple; and if we are to argue from the progress that I have indicated as already having taken place in the fixed batteries we use in connection with our distribution systems, it is reasonable to suppose that similar progress will be made in the portable accumulators, and that a few years hence we shall see great developments. It is probable that these developments will rather take the form of better organization of methods of using and increased facilities for re-charging and repairing the accumulators we already have; but this is more the province of the commercial organizer than of the engineer himself.

It is quite certain that an enormous impulse will be given to the production of electrically-driven vehicles when the boxes of accumulators and the means of charging them are sufficiently standardized.

[1] "The Distribution of Electrical Energy." By J. F. C. Snell, M. Inst. C. E. Minutes of Proceedings Inst. C. E., vol. clix. p. 143.

ELECTRIC TRACTION.

The railway problem, which is of the highest interest and importance to my audience, would occupy not one but a series of lectures. I must confine my remarks to pointing out that one solution of the problem first set for us by Messrs. Mordey and Jenkin in their paper[1] read here in 1902 seems already within our reach, namely that of the utilization of single-phase alternating currents for long-distance transmission, which only requires two insulated wires and two contacts. The engineering and mechanical secondary problems still unsolved are easy ones. We have the choice between the type of series-motors made by Finzi in Italy and that of the Winter and Eichberg compensated repulsion-motors made by the Allgemeine company. The difference between these two types lies principally in the size of the transforming apparatus which must be carried on the train. In the first instance this must be equal in capacity to the total output of the motor equipment, whereas with the repulsion-motor the transformer need only have a capacity of one-tenth the rated capacity of the motors. Our future choice lies between these two or similar systems, or modifications of them.

I think we can even now answer two questions. The first is: Can electric traction supersede steam haulage at the schedule speeds which at present obtain on our railways? To this question we electrical men say that, although there are many secondary problems arising out of it, they are all easily solvable, and we have no doubt whatever that we can answer the question in the affirmative. The second railway question is: Can we by the introduction of electric haulage raise to a notable degree the present schedule speeds, and from this cause alone become very formidable competitors to long-distance steam haulage? Although there are many electrical engineers who would answer this question in the affirmative with as much confidence as they answer the first one, yet personally I am not quite so sure. I see that, spurred by our electrical competition, the designers of the steam locomotive are likely to make further efforts, and I feel sure that if we electrical men can work to schedule speeds of 100 miles an hour, the steam locomotive can also be improved so as to work at the same speed with equal safety.

As to long-distance goods traffic, I do not think we are likely to attack this problem for years to come. None of the engineers whom I have met, either in England or in America, seem to think that electricity is ever likely to replace steam for this work; of course I mean in our present knowledge of the cost of the generation and supply of electrical energy.

SPEED AND TORQUE VARIATION.

Our railway problem would be greatly simplified by the solution of another mechanical problem closely connected with it, or with the driving of any machinery such as rolling mills, in which the starting-torque is very great and very variable, whereas the source of energy for driving is constant. You are all familiar with the attempts to deal with this matter mechanically on the motor-car or motor-omnibus by the change-speed gear, but I believe and hope that the real solution is an electrical one. Ward Leonard has worked it out by the introduction of a motor-dynamo having a variable field, but up to the present time all the devices have been heavy and costly; still the ability to produce by electrical means variation of speed or of torque will be of the utmost value in aiding the work of the mechanical engineer, whether in railway works, rolling mills, cranes, hoists or in the propelling mechanism of the steam, petrol or electrical vehicles which are now beginning to be used so largely on our roads.

ELECTRIC MEASURING INSTRUMENTS.

Probably the branch of electrical engineering which has already made its greatest advances is that of perfecting our measuring-instruments. This is a matter on which I could dwell with loving interest, but the time prevents me from dwelling on it at any length. The instruments that we have already at command for measuring continuous currents are already so accurate and so low-priced that they are commencing to be used for many purposes quite outside the field of electrical engineering proper. By combining them either with a thermal couple, such as copper-constantan, iron-constantan, platinum-rodium or similar alloys, they become the most accurate and convenient methods of measuring temperature from the minute changes which have to be observed in measuring lunar radiation up to extremely high temperatures close to the melting point of platinum. The standard methods of checking these coil instruments by means of the potentiometer are already very perfect; but when we come to the measuring of alternating energy, although the instruments for measuring separately the current and pressures are satisfactory, yet no completely satisfactory method at all approaching the accuracy and simplicity of the continuous-current methods for measuring power are as yet available in this case. This is due to the difficulty of measuring current and pressure simultaneously, and under such conditions that no corrections have to be made for the difference in phase between the two, wherein lies the all-important power factor. Probably the solution of this problem lies in the further perfecting and simplification of electrostatic means of measuring alternating pressures. Much is to be hoped for from the further development of the beautiful spherical electrostatic instruments devised by Price.

ELECTRIC LIGHTING.

The problems of the further utilization of electrical energy for the purposes of our daily life are of extreme interest. The first strong impetus given to the discovery of improved means of generating electricity arose from the desire for electric light. First came the arc-light, followed by the incandescent lamp, and both have been perfected up to a certain point. By the invention of the enclosed arc we have greatly reduced the cost of labor of recarboning our lamps; their utility has been increased by the perfecting of smaller details of manufacture; and the carbon filaments of our smaller lamps have also reached better efficiency and regularity of light-giving power than was at first the case. Still, as at present produced, they fall short of what is desired in point of efficiency; but there is nevertheless room for hope and material benefit in this respect. For years past many minds have been attempting to solve the problem of obtaining increased light from an incandescent filament or wire. The successive appearance of the Nernst, the Auer von Welsbach, the Osmium, and finally the Tantalum lamp indicates the more or less successful efforts that have been made, and which seem likely to yield satisfactory results.

The development of the Tantalum lamp has been a striking instance of the way a problem of this kind ought to be attacked. The search for a suitable wire was set about in a thoroughly systematic manner. Tantalum was tried, as it was one of a group of metals which from their known atomic values would be likely to give the desired results. It was then hardly known in its metallic form, so that during the search it was necessary to devise means for obtaining it in sufficient quantity, to draw and toughen the wire and to mount it in a suitable manner. The result has been a lamp which, although not perfect, does yield many of the results that were expected from it, and the inquiry will very probably lead to notable additions to our knowledge of this part of the lighting problem.

Quite recently we have witnessed the introduction of lamps yielding strange colored lights, on the one hand the blue of the Cooper-Hewitt mercury-vapor lamp and at the other end of the scale the orange flame carbon arc-lamp. An investigation into this question of the colors which are best suited to obtain clear visual definition by artificial light is sorely needed. Such an investigation was begun 10 years ago by Langley in America, Blondel in France, and by Barr and Phillips in this country, but of late years little further has been heard on this extremely important subject. The revival or re-introduction of these modern lamps shows that the problem is an important one. More than 12 years ago Langley defined the brightness of light as as the intensity of retinal absorption, and probably this is what most of us believe it to be. He pointed out that the effect of lights of different colors on

[1] "Electrical Traction on Railways." By W. M. Mordey and B. M. Jenkin, M. Inst. C. E. Minutes of Proceedings Inst. C. E., vol. cxlix. p. 40.

the retina varied with the individuals and with the age of individuals, so that the greatest visual intensity is obtained with younger men when the light is rich in yellow rays, and with older men when the light is richer in the green and violet rays. Now that we have at command electric lamps that can give us colors of both kinds it will be interesting to notice how far Langley's ideas are corroborated by investigation of them on a larger scale. We are told that the Cooper-Hewitt lamp gives excellent definition and does not fatigue the eye when exposed to the trying work of reading fine scales, or wherever high definition is of first importance, and has to be obtained by the aid of artificial light.

While on the lighting question I wish to mention a matter which has interested me, although it can only indirectly be called an electrical problem. Years ago I was fortunate enough to observe the following phenomenon: While in a carefully closed tent with a double top and walls thick enough to exclude the faintest ray of the Indian sun, I, in the course of a severe thunder-storm was able to distinguish minute details of the outside scenery by the walls being rendered practically transparent by intense flashes of lightning. Personally, I have no doubt of this, but the phenomenon appeared inexplicable until it was suggested to me that the lightning flashes were so rich in violet short-wave-length rays of low refrangibility that they were able to render transparent all substances which owe their opacity to the centrifugal refraction of the white or yellowish ray of sunlight. As in the Cooper-Hewitt lamp, we are now able to command rays of the right color; by condensing a beam of this blue light we may hope to render transparent many vegetable substances, such as wood and similar materials, which have hitherto been considered completely opaque to ordinary vision.

COOLING BY ELECTRICITY.

A problem of real moment to both suppliers and users of electrical energy would be the discovery of a direct method of producing artificial cold by electrical means. If we had a ready means of producing artificial cold so as to obtain cold storage in our larders and so preserve our perishable foods, vegetables and fruit, it would obviously greatly add to the pleasure of our lives and to the economy of our housekeeping. Of course we can now produce artificial cold by connecting an air compressor to be driven by an electric motor, and by expanding the air into the cold storage chamber, but the method is costly and cumbrous. Probably something may be done by a well-designed high-speed air compressor, but the real solution we are looking forward to is a direct method of producing cold from the electrical energy in our supply mains, and this probably is a problem for the electro-chemist, as we may conceive the apparatus taking the form of a reversed battery abstracting heat from the surrounding air.

The recent experiments of Lodge in dispersing fog and collecting dust by communicating static charges to the atmosphere containing such particles deserves mention as worthy of future development.

HEAT FROM ELECTRICITY.

Time will not permit me to speak at any length on the interesting subject of electrical heating. At first our attention was directed to means by which our electrical energy could be used for the production of low temperatures, such as radiators for heating our rooms, boiling water, heating ovens, and similar domestic uses, and although the demand for this class of apparatus up to the present has not been great, owing to the cost of the energy being in most cases still too high, yet steady progress has been made and in certain towns its use has been extended in a very encouraging manner; but there is another use for electric heating, and that is the production of much higher temperatures, such as those required by the chemist and metallurgist. The importance to the mechanical engineer, chemist or physicist of being able to maintain, in quite small furnaces, extreme regularity of high temperature for very long periods of time cannot be overestimated, and this problem is already satisfactorily solved; but when we deal with electrical furnaces on the larger scale I may point out that, although when Keller read his paper[1] on electrical metallurgy before the Iron and Steel Institute, in 1903, the possibility of electric smelting taking the place of heating directly by fuel was received with much incredulity, since that time so much attention has been given to the matter that this problem has already been successfully grappled with and appreciable advances have been made in the practical application of electrical smelting. De Laval, Ross and others have arrived at very concordant results, and already the Heroult furnace for the production of steel from scrap-iron has been carried out on a commercial scale in France and in Sweden, and in both cases we are told that the high quality of steel thus obtained shows that the process is already a commercial success and may be of great importance to those countries that possess water power, so that this direct process of electric smelting may be readily developed.

THE INTERDEPENDENCE OF THE SCIENCES.

In discussing the past and future problems of the core and coil, on which so much of the efficiency of our generating, transforming and utilizing apparatus depends, and again in discussing the problems of storage, of the electrical driving of our railways, and of the further utilization of electrical energy for the needs of our daily life, I have been struck with the extreme difficulty I feel in confining myself to matters which have been hitherto considered strictly electrical ones. I am sure all my brother engineers will feel with me that the necessities of our profession compel us to take up and study the far wider field of knowledge of general engineering. The power engineer is called upon—at all events, in this country—to deal with the problems of fuel and water supply, the use of steam, or the internal-combustion engine, and the whole range of subjects connected with the properties and strength of materials, and of the methods of manipulating them, which by many are considered purely the province of the mechanical engineer. We claim that already we have profoundly influenced that profession. Our requirements have already modified boilers, have practically given to the world the modern high-speed steam engine, the steam turbine, and have been a predominating influence in developing the internal-combustion engine.

THE DISTRIBUTION OF POWER.

Finally, I believe the greatest problem of all, and the one which will have the most profound influence on the well-being of our fellows, is the satisfactory development of our power schemes, by which we hope to send the population back to the land. Power-distribution schemes of various degrees of magnitude have already been started in many countries. In those where water power was available they have made considerable progress; but in this country, where we have to look to the generation of our power from fuel, the problems involved are of the highest interest and are extremely hopeful of speedy solution; and the social consequences that will follow on them are likely to be so important to the health and better development of our race that they deserve the most careful consideration of our best men.

The necessity for bringing our working population into huge factories so that they may work within the range of power allowed by revolving shafting is already at an end; nearly all power can be supplied through electric motors, and therefore the factory units themselves can be small, spaced more widely apart, and many classes of manufacturing processes can be carried out most perfectly in the worker's own home, unaided by the other members of his family.

Already in Switzerland, France and Germany trades are being profitably carried on under conditions very closely approaching those that have been foreshadowed to us by the promoters of garden cities. A large proportion of our workers may in the future carry on their business at home in a workshop attached to the dwelling-house, and separated from the neighbor by the garden in which the children can grow up under the best conditions of light, air and sunshine.

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[1] "The Application of the Electric Furnace in Metallurgy." By A Keller. *Journal* of the Iron and Steel Institute, 1903, No. 1, p. 161.

Air hardened steel tempered in the same way as high speed steel, is said to give good results.

The Performance of a Large Experimental Bearing.*

BY ALBERT KINGSBURY.

The following tests were made in 1904 by the Westinghouse Electric and Manufacturing Company at its East Pittsburg works. The special apparatus required was made for the Niagara Falls Hydraulic Power and Manufacturing Company, at whose request the experiments were undertaken.

The apparatus shown in Figs. 1 and 2 consisted of a horizontal shaft supported in two bearings, each 9 inches diameter, 30 inches long, with a third bearing 15 inches diameter 40 inches long, midway between the supporting bearings. The 15-inch bearing was pressed upward against the shaft by means of a lever made from two 15-inch I-beams, weighted at its outer edge. The 9-inch bearings each carried half the load, less half the weight of the shaft. These three bearings are designated *A*, *B* and *C*, beginning at the left in Fig. 1. The shaft was driven by a Westinghouse No. 50 (150 horse-power) direct-current railway motor; for shaft speeds not exceeding 500 revolutions per minute the motor was mounted as shown in the figures, with a 21-tooth and 50-tooth gear; for higher speeds the motor was mounted on the floor, with a 26-inch pulley on the armature shaft and 12-inch pulley on the test shaft, driving by an 8-inch double leather belt. The electrical power supplied to the motor was the only available basis for estimating the friction of the bearings; the motor efficiency being found by tests to be approximately 67 per cent. at 45 to 54 amperes, and 85 per cent. at 114 to 127 amperes. The total power consumed by the bearings, *A*, *B* and *C* was determined, but their separate frictions could not be determined.

The shaft journals were made true with lead laps and finished with emery cloth. The bearings were lined with genuine babbitt metal, scraped to fit the shaft. The clearance over the top and sides was about 0.03 inch in *B*, and this proved to be ample. The vertical clearance in *A* and *C* was about 0.007 inch or 0.008 inch, and was not enough to provide for the expansion of the shaft and the inner part of the bearings under the rapid heating of the most severe tests. The bearing sleeve of *B* was cored for water cooling; the lower half only was connected for water circulation, with thermometer wells at inlet and outlet, and with a 1-inch water meter at the inlet.

The bearings were flooded with oil from a small supply tank, to which the drip was returned by a motor-driven pump through a coil of 140 feet of 1-inch pipe, with provision for water cooling, as desired. The oil supply pipe to each bearing was connected into a wide and deep groove in the face of the babbitt, parallel to the shaft, and extending nearly the full length of the bearing; the groove was located at the top of the bearing in *B*, and at the side in *A* and *C*. Detailed data of the conditions and results of the tests are given in the appended table.

The test runs were generally of about seven hours' duration each day, starting with all parts cool, and bringing the shaft up to full speed as quickly as possible. If

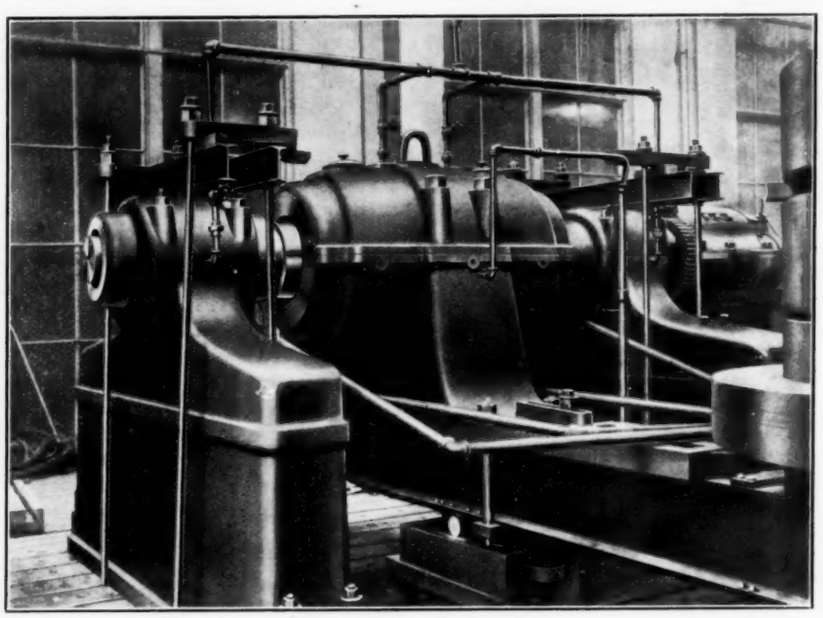


FIG. 2. THE APPARATUS EMPLOYED.

*A contribution to the discussion on bearings at the December 1905 meeting of the American Society of Mechanical Engineers.

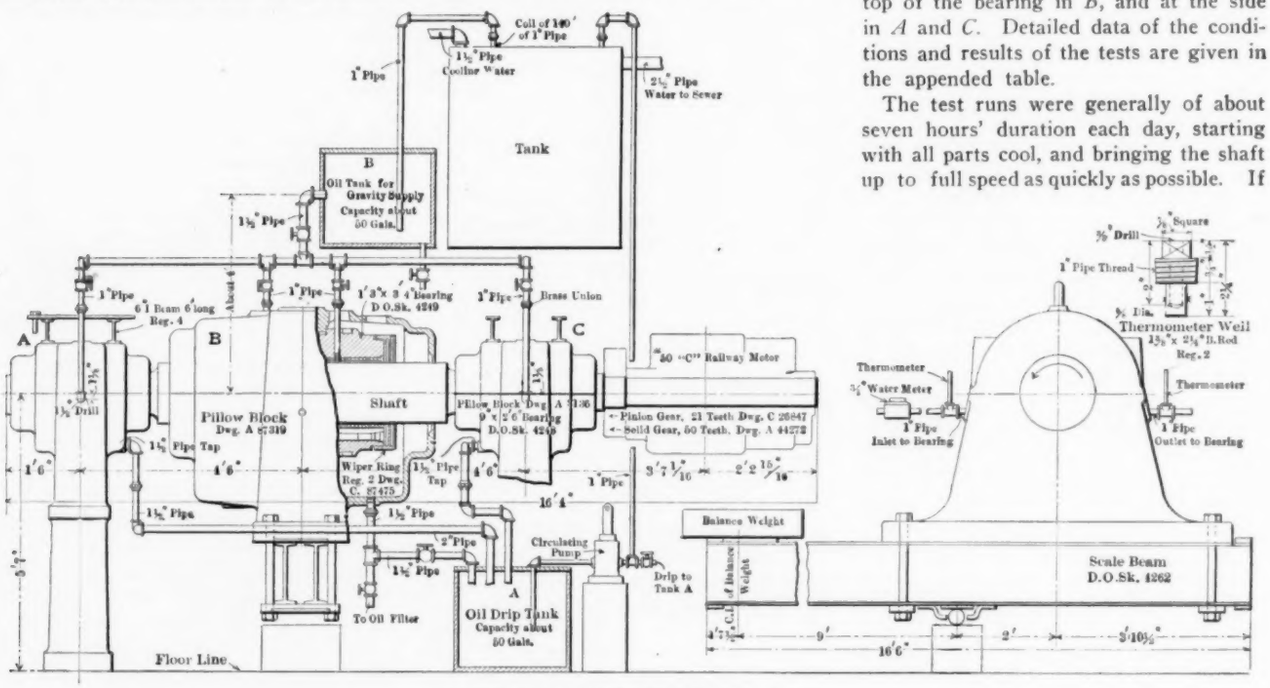


FIG. 1. THE APPARATUS EMPLOYED.

the speed was quickly raised to about 1000 revolutions per minute it was found that the expansion of the shaft and inner part of the bearings caused binding, particularly in the bearing *C;* hence to reach the higher speeds it was necessary to accelerate slowly, allowing at least three hours for heating the outer parts. The load was relieved at starting because of the very great torque that would be required for starting under load. Bearings *A* and *B* became somewhat damaged, apparently from raising the speed too rapidly in the final run (No. 13) in which a speed of about 1350 revolutions per minute was attained within 4½ hours, including a stop of 1½ hours, the load being 101,000 pounds.

The thickness of the oil film between the shaft and the bearing *B* was measured approximately at successively reduced speeds under a load of 94,000 pounds at the close of test run No. 12. Four Bath lathe indicators were used for this purpose, two being attached to each end of the housing, with contacts on the shafts at the positions *D* and *E*, respectively (Fig. 3). The relative displacement of the shaft and bearing by the oil film, as shown by the curve (Fig. 3) is greater at *D* than at *E* at all speeds; this condition as theoretically proved by Osborne Reynolds ("Theory of Lubrication," Phil. Trans., 1886) is essential to complete lubrication and is automatically maintained. It should be noted, however, that the film thickness was probably greater than the measurements indicated, owing to the flexure of the shaft. The speed could not be controlled below 400 revolutions per minute owing to the lightness of the load on the motor; but the rapid increase of friction due to imperfect lubrication occurred at about 300 revolutions per minute as the speed was reduced. The lower limit of speed for complete lubrication might be expected to be determined by the conditions in the bearing *A* or in *C*, or both, rather than by those in *B;* nevertheless, the curve for the point *E* appears to show that the metals in *B* came into contact at about 300 revolutions per minute, the apparent lower speed limit.

As will be seen from the table of data and results of the tests, it was found possible to run the bearings with loads and speeds greatly exceeding the ordinary values in practice, even without water-cooling the bearing sleeve. The extreme case of a successful test is shown in column 12, in which a run was made under 94,000 pounds' load at 1243 revolutions per minute, with only a very small amount

A and C-9"x30" B-15"x40"		Tests with heavy Mach. Oil.								Tests with Paraffin Oil.		
Test Number		3	4	5	6	7	8	9	10	11	12	13
Load on B Tons		25	25	25	25	25	25	33.6	42.3	47	47	50.5
Pressure on B lbs. per sq. inch nom. Area		83	83	83	83	83	83	112	141	157	157	168
Load on each A and C Tons		11.1	11.1	11.1	11.1	11.1	11.1	15.4	19.7	22.1	22.1	23.6
Pressure on A and C lbs per sq		82	82	82	82	82	82	114	146	64	164	175
Shaft Speed	R. P. M.	306	309	506	180	179	301	454	480	946	1243	1286
	Ft. per min. B.	1200	1215	1990	708	704	1180	1785	1890	3720	4900	5050
	Ft. per min. A and C.	720	730	1190	424	422	710	1070	1030	2220	2930	3030
Motor Amperes		53	54	57	51	45.5	49.5	51	53	122	114	117
Volts		253	260	428	141	126	227.5	350	379	301	368	392
Electrical H. P.		18	18.9	32.7	9.68	7.7	15.1	24	26.9	49.3	56.3	61.6
Friction H. P. Total for A B & C		12	12.6	21.7	6.43	5.12	10.1	16.	17.9	41.9	47.8	52.3
Friction Torque lbs. ft. Total A B & C		206	214	225	188	150	176	185	195	233	202	213
Average coeff. of Friction for A B & C	Starting (cold)	.121	.146	.....	.....	.....	.....	.....	.....	.....	.....	.....
	Running	.0044	.0045	.0048	.0040	.0032	.0037	.0029	.0024	.0025	.0022	.0022
Temperat. Centigrade — Atmosphere		17	18.7	20	20.4	20	16.8	17.3	19.7	20.5	20	19
Top Sleeve of Bearing	A	48.8	44.9	54	35.8	42	44	52.2	52.9	58.7	74	97
	B	.....	.....	.....	.....	.....	.....	.....	.....	.....	67	58
	C	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Oil Supply		47.5	45.9	55	40.5	45	45.1	57.8	54.9	67.2	91	117
Oil Drip	A	24.6	12.4	17.7	9.4	32.5†	11.7	14.7	16.4	21.7	20.6	16.5
	B	.....	.....	.....	.....	.....	.....	46.9	47.	58	72	65
	C	.....	.....	.....	.....	.....	40.7	49.2	51.3	56.	61.5	54.
Cooling Water for Bearing B	Supply	7.	6.3	7.6	8.1	19.2	10.9	46.8	49.5	59.5	66	62.5
	Discharge	18.	13.4	14.6	16.3	32.6	37.9	10.9	11.8	11.	12.	16.
	Rise of Temp.	11.	7.1	7.	8.2	13.4	27.	47.2	48.8	38.5	69.6	69.
Lbs. Oil Supplied per min.	A	.....	4.	6.2	3.1	3.9	4.4	36.3	37.	27.5	57.6	53.
	B	.....	11.6	14.1	3.1	10.9	4.0	6.4	8.2	1.2	9.4	2.8
	C	.....	2.3	3.5	1.5	1.8	2.7	3.1	5.8	10	7.6	5.9
Lbs. Cooling Water per min. to B		9.6	13.7	24.5	9.1	.3	.55	3.8	5.	8.5	9.9	10.
Per cent. of total heat carried from A B & C	By Oil	.....	.....	.....	.....	.....	.....	.92	.49	6.2	.3	.3
	By Water	22.3	19.6	20	29.5	2.	3.7	63.	80	61.2	61.	36.
	By Air and Radiation (by difference)	.....	.....	.....	.....	.....	.....	5.3	2.6	10.3	.92	.76
		.....	.....	.....	.....	.....	.....	31.7	17.4	28.5	38.1	63.2

† Oil supply was not water cooled.

DATA AND RESULTS OF TESTS.

Temperatures of bearings constant except in 13, for which the data given were taken just before the bearing seized at 1350 revolutions per minute.

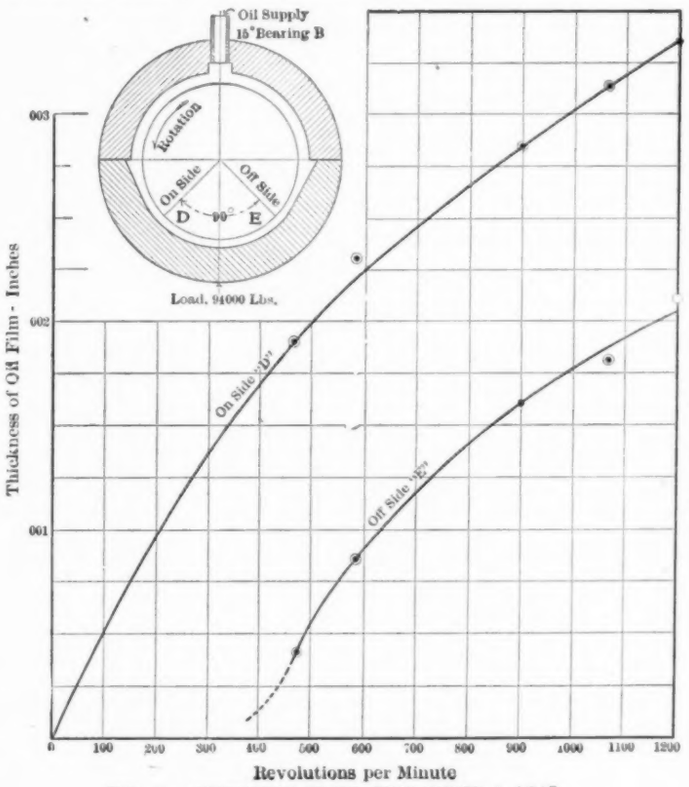


FIG. 3. THICKNESS OF OIL FILM UNDER A LOAD OF 94,000 POUNDS USING PARAFFIN OIL.

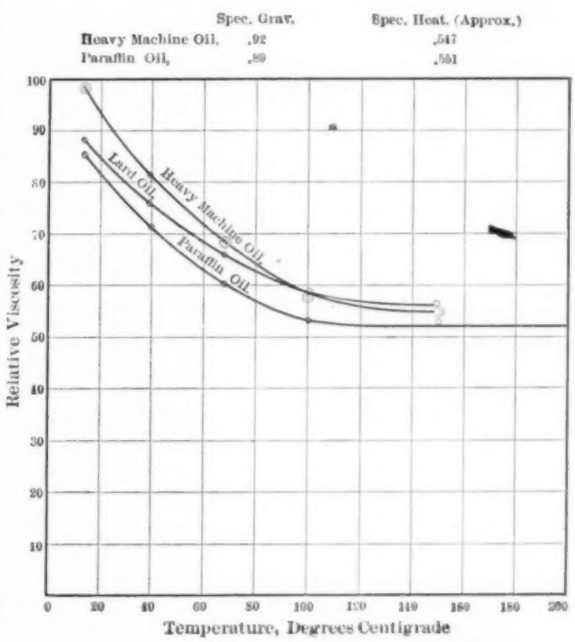


FIG. 4. RELATIVE VISCOSITIES OF LUBRICANTS AS SHOWN BY DOOLITTLE VISCOMETER.

of water run through the bearing sleeve, merely for determining its temperature. The oil supply, however, was cooled in all the tests except in No. 7, and the first half of No. 13.

It may be noted in the table that the power required to drive the shaft was very nearly proportional to the speed of rotation, independently of all other conditions, such as load, final temperature attained and lubricant used. This result is probably not a general law, but is noteworthy even as an accidental relation.

The current to operate the single-phase electric locomotives on the New York, New Haven & Hartford railroad will be furnished by three 4500-h.p. Westinghouse-Parsons turbo-generators, 1100 volts, 3000 alternations, single and three-phase, excited by two 125-kw. exciters, driven by Westinghouse steam engines. The power house is to be located at Cos Cob, Conn. It is intended to use catenaries to support the trolley or conductor line, hung from cross girders every 300 feet. It is stated that by September, 1906, they will be ready to run trains by electricity between New York and Stamford, Conn., and it is expected that in 1908 the electrification will be completed to New Haven.

Oxygen is stated to occur frequently in zinc in the form of zinc oxide and when present in considerable quantities it produces a pasty metal, the so-called burned zinc, which gives castings without sharp edges and which are brittle and difficult to work with a chisel and file.—*The Metal Industry.*

Automobile Construction—VIII.

BY F. C. MASON.

The rotary gear pump in Fig. 23 is easily made and very efficient. The most difficult part to make is the casting. Of course when these are made in quantities and jigs are used for boring and facing it is an easy job.

The bearings and recesses for the gears must be parallel and the right distance apart. Chuck and face both case and plate, then fit the screws to the plate and to the case. Take them apart and lay out the center distance on the bosses of the case, strap the case to the face-plate of the lathe, locate the center mark on one of the bosses with the indicator and bore for the bearing, shift to the other center and bore for the other bearing. Chuck a piece of ¾-inch cold rolled steel, turn a short mandrel and force the case on sufficiently tight to hold while boring the gear recess. Secure the plate to the case and bore the bearing in the plate. Proceed as before for the other gear recess and the bearing in the plate and turn three plugs 3/16 inch long by ½ inch diameter to fit the holes and make the bearings water tight; the stuffing box on the shank of the driving gear prevents the water escaping there. The gland is shown in detail and should be made of brass or machine steel. The gears (also shown in detail) should be made carefully and true to size so that they will fit perfectly when finished.

PROPELLER SHAFT JOINTS.

Fig. 24 shows an easily made universal joint for the propeller shaft. You can procure standard drop forgings to make these parts of; they may not finish exactly to the sizes given but that is immaterial. About as cheap a way for a single set is to make them of 1⅝- by 3¼-inch machine steel. For the slip joint with the square hole, I would suggest using a piece of steel 6 inches long; drill a ¾-inch hole through lengthwise. Take two pieces of tool steel, one ¾ and the other ⅞-inch square by 12 inches long, and punch the hole through hot. You can easily get a very good job in this way. The cross shown in detail can be made from a 2x2x1¾-inch pipe. Drill and ream the holes and then turn the projections to size on a mandrel. Remove the surplus stock in the shaper or milling machine and, after finishing, case-harden.

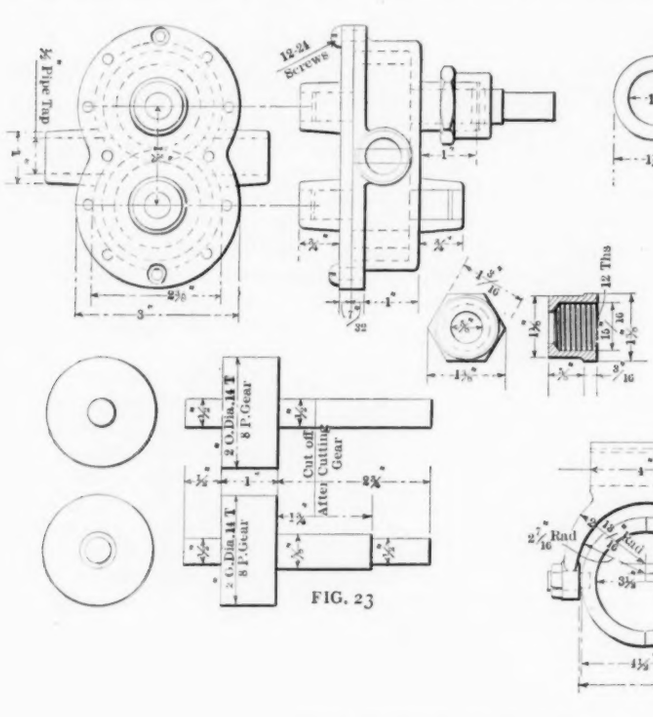


FIG. 23

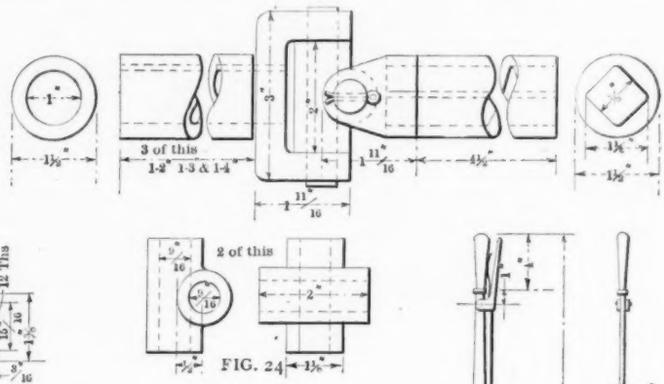


FIG. 24

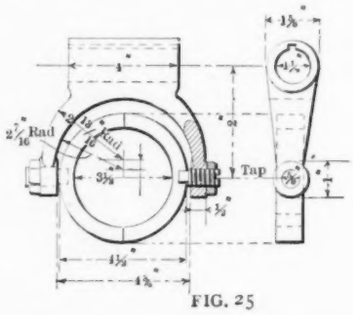


FIG. 25

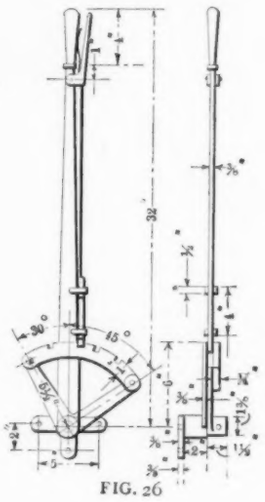


FIG. 26

PUMP, PROPELLER SHAFT JOINTS, TRANSMISSION LEVER AND QUADRANT.

Fig. 25 shows the clutch shifter, which is a machine steel forging. The ring also is made of machine steel and case-hardened. After turning it is sawed in half.

TRANSMISSION LEVER AND QUADRANT.

Two views of the transmission shifter lever and quadrant are presented in Fig. 26. These parts are made entirely of hard brass, excepting the dog and rod. The lever is shown straight in the side elevation but if it is necessary to offset it to clear the seats properly it is easily bent. The drawing does not show the exact location of the quadrant notches, as it is better to locate them when assembling, in order to insure accuracy.

The other levers, bell cranks, etc., I do not intend to show in detail as I think the readers of these articles will know

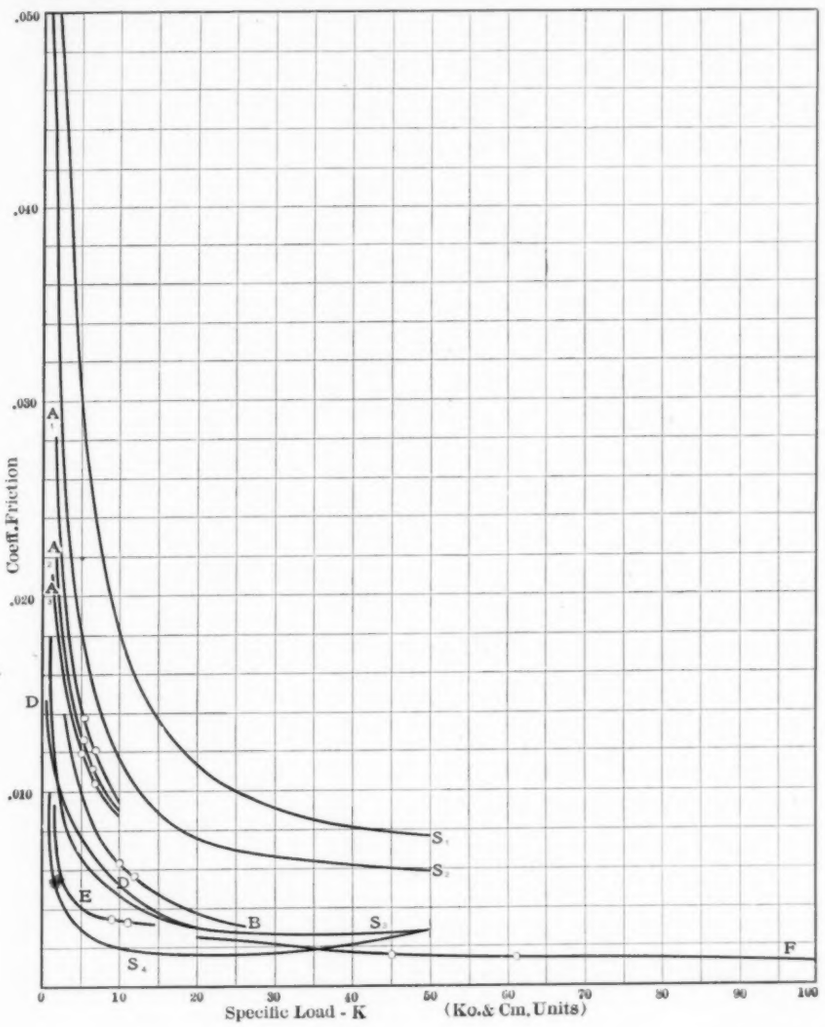
just how to make them. The hub brake has already been illustrated and the transmission brake is made on exactly the same lines except that it is smaller.

Ball and Roller Bearings.*

BY HENRY HESS.

My contribution to the general discussion of bearings will be confined to a necessarily rather brief and cursory review of ball and roller bearings, and a slightly more detailed reference to ball bearings of a type with whose development and operation I am personally familiar.

Both ball and roller bearings are of hoary origin. The roller used under a block of stone by the ancient Egyptians and in exactly the same way under the skids of a crate containing the latest product of the modern machine shop show familiarly the advantage of the substitution of rolling for sliding friction.



The specific load is the load per unit of the carrying element; for plain bearings such element is the projected journal area or : $K = LD$.

For roller bearings the projected area of the carrying rollers (one-fifth of the rollers only is considered as carrying) is $K = \frac{Z}{5} LD$.

For ball bearings the squared ball diameter of all carrying balls is taken (one-fifth of the balls only are taken as really carrying) $K = \frac{Z}{5} D^2$.

Curves "8" are for a babbitted journal — S_1 at 1100 RPM., S_2 at 380, S_3 at 64, S_4 at 12.

Curves "A" are for rollers in a bronze cage circumferentially fitting and supporting each roller throughout its length. A sleeve on the shaft and a liner in the box carry the rolls. Hard and soft rollers were tested. A_1 at 1100 RPM, A_2 at 285, A_3 at 190.

Curves "B" are for hollow rollers on loosely fitted pins that connect the end cages. No liners are used on the shaft or in the box. R. P. M. from 190 to 760.

Curves "E" are for flexible spiral rollers; the rollers are loose and are alined by three longitudinal bars connecting the end cages. No liners for shaft or box are employed. 56 to 1100 R. P. M.

Curves "F" are for a ball bearing of the two point curved ball race type at 65 to 1150 R. P. M.

The range of permissible specific loads, as indicated by the appearance of the bearing after long continued runs, is shown by small circles on the curves.

FIG. I. TESTS OF PLAIN, ROLLER AND BALL-BEARINGS.

The early recognition of this advantage led naturally to many attempts at the employment of rolling elements in the journals of machines. Until relatively recent days such attempts have been chiefly failures—interesting, but failures nevertheless. The causes were simply imperfections in the shape of the rolling elements and their supporting surfaces, resulting in the loads being actually imposed on insufficient areas, though, theoretically, greater ones were provided. Then, too, the laws for securing true rolling and eliminating all sliding have been formulated only relatively recently, so that at this day it is not uncommon to find thrust bearings with cylindrical rollers, that necessarily can have pure rolling at only a single girdle in their length while all other parts must slide, since only balls of cones whose apices lie in the center of revolution can roll truly.

The bicycle is responsible for the widespread realization of the possibilities of the saving of work by ball bearings; without these it probably would never have had the vogue it acquired; the rider who remembers the difference in freshness at the end of a half day's tour on a wheel fitted with cone bearings and one fitted with ball bearings can bear eloquent witness. Simple as is the design of a ball bearing of correct action, yet but few gave proof of anything but mistaken ingenuity. The saving element in the bicycle was the light load. The hopes cherished and translated into practice for more ambitious mechanisms soon resulted in failure. This was attributed to insufficient bearing surface. Further development was along two lines: One body of constructors fell back to rollers, with the idea that a roller had line and therefore more support than a ball with its theoretical mere point; others multiplied the number of balls.

GERMAN EXPERIMENTS ON BEARINGS.

Some years ago Professor Stribeck, the able head of the Technical Laboratories at Neu-Babelsberg, near Berlin, undertook for one of Germany's leading industrial establishments a thorough investigation of the entire subject of the relation of sliding, roller and ball bearings. The maximum loads under which the temperature remained constant was determined. There was also considered the time that a bearing had to be run under a given load until such constant temperature was attained.

The results are given in Fig. 1 in the relation of the co-efficient of friction (referred to the shaft diameter) to the specific loads. For sliding bearings the specific load is the pressure in kilograms per square centimeter of projected journal area; for roller bearings one-fifth of the number of rollers times the length and diameter of the rollers is considered as the equivalent of the projected journa

* Abstracted from the discussion on Bearings at the New York meeting of the American Society of Mechanical Engineers.

area; for ball bearings one-fifth of the number of balls times the square of the ball diameter is considered as such equivalent. Within the limits of numbers of balls and rollers in an ordinary journal one-fifth of such number may be considered as practically sustaining the load, though naturally not equally. For roller and ball bearings angular velocity has not much influence within quite wide limits; wider for balls than for rollers; note the revolutions per minute figures of the curves.

Noticeable is the very low co-efficient of friction of the roller—and more especially of the ball bearing. A further marked characteristic that these tests developed was the value of the co-efficient of friction at rest; with roller bearings the latter was far less than with plain bearings, and for the ball bearings the friction of rest and motion was found to be identically low; this is a very important quality in all machines that must be frequently started and stopped, as suburban and urban train and car service.

Stribeck concludes that for continuous service with roller bearing K may lie between 6 and 11 Kg.

For lineshafts employing soft rollers the journal length works out but slightly less than the usual plain box length; K should lie well toward the lower limit. For hardened rollers on hard surfaces K may lie toward the higher limit. It is important that the rollers should be parallel to the shaft when under load. Tests of various cage constructions and of free rollers have shown that this is attained most nearly when the rollers are not tied together but are left free to adjust themselves; lack of truth will cause a slewing of the rollers as they pass under the load; as they pass out to the free side of the journal they can again straighten out unless confined in rigid relationship to those still under load.

At first glance the relatively high carrying capacity and low friction of the ball bearing as compared with the rollers seems strange. The explanation is not far to seek. For pure rolling there would be no difference between ball and roller; but pure rolling is a theoretical possibility merely, requiring for its realization absolutely true shapes initially, and inelastic materials that will not change shape under load. To produce a series of rollers that are truly cylindrical alike as to diameters and also a cylindrical shaft for them to roll on, and a truly cylindrical box to roll in within the requisite small limits of error is difficult and commercially not realizable with existing shop facilities. More serious still is the fact that under heavy loads even such accuracy as may be had is largely defeated by the deflections of the machine framing. The familiar tendency of rollers to skew is the result of such lack of truth or deflections. It follows that the theoretical line contact of the roller does not exist in fact, but is limited to but a short portion of the roll length.

Difficult as the production of a true ball is under ordinary shop conditions, specialists in the manufacture of this article can deliver balls at relatively small cost that are true spheres to within less than one-ten-thousandth part of an inch. This fact suggested the substitution of a large number of balls for a small series of rollers in the solution arrived at by Simonds of Fitchburg; there remained still the difficulty of the lack of truth of the shaft and box; to make up for this by selecting balls to suit successive zones was a way out, but hardly a commercially practicable one. Many constructions were devised for rocking and compensating mountings that would also take care of the difficulties introduced by deflection under load of the supporting shaft and box. Finally a German engineer, Mr. Riebe, decided that the proper thing was to employ but a single row of balls and so have a journal of no appreciable length that therefore could not cause trouble by deflection, and then to proportion the diameter and number of balls to the load to be carried. As the number of balls in a single circle was necessarily limited, and as the journal diameter could not be indefinitely increased, it became important to develop the carrying capacities as affected by the shape of the ball tracks and the nature of the materials. Tests were made of ball bearings of various shapes and relationship of contact. It was found that the frictional resistance was least for balls rolling between straight line sections, Fig. 2, of the two-point order of contact. It was further found that increasing the points of contact to three and four, Figs. 3 and 4, gave higher frictional resistance, due no doubt to the slight variation from the correct relationships of the contact points and the centers of revolution of balls or journal; the carrying capacity was not materially different for these forms. Theoretically, No. 4 should carry rather more, but the greater tendency to partial sliding, as compared with the pure rolling of No. 2 offset this. Curving the race, Fig. 5, resulted in materially greater carrying capacity with but barely measurable increase in friction.

PROGRESS IN BALL BEARING DESIGN.

Naturally, as the carrying capacity of a bearing with curved race sections was greatest, it followed that any openings for side filling of the balls, which would break such section and therefore reduce the capacity, must be kept at the unloaded side or avoided altogether. Riebe's design, Fig. 6, was along the former lines; the ball was introduced through a cut in one race at the side; the continuity of the race was restored by a clip; but still the joint was a weakness, so that the screwhead was utilized to keep this joint at the unloaded side. Later a Mr. Conrad suggested that it would be better to have no weak point, but that both races be of uniform section throughout; better still, he also accomplished this by filling in as many balls as would fill one-half of the bearing, assembing this, distributing the balls and then inserting separators that could maintain such distribution and so lock the whole into a complete unit. The lesser number of balls were compensated for by larger sizes and by the possibility of somewhat higher loading under most conditions owing to the absence of certain interferences incidental to every ball bearing having balls in unyielding contact.

Further experiments—again carried out by Professor Stribeck—on bearings and balls of various sizes and races of various degrees of curvature and many standard and special steel alloys, developed data for the reliable design of bearings suited to all sorts of conditions.

That these two constructors have, backed by the researches of Professor Stribeck, been successful to the point where the most conservative need no longer shy at the employment of ball bearings under any conditions is best proven by the consideration of a few typical examples from actual practice. As the mention of firms is more or less out of place in a discussion such as this, no names appear, but it may be said that the various prints shown all represent constructions that have been actually carried out and are standard practice with firms of international reputation.

Fig. 7 is a continuous annular race; it consists of an inner race A an outer race B, both provided with curved ball tracks that are uniform and unbroken around the complete circumference and of a series of balls C, separated by elastic distance pieces D, which latter are usually provided with felt plugs for storing up lubricant.

EXAMPLES OF BALL BEARINGS FOR HEAVY LOADS.

The first example shown Fig. 7 is the mounting of a tubular cement mill. This is also interesting as a journal of somewhat unusual dimensions—39 inches—and will carry safely 40,000 pounds of weight in such a machine.*

In a pillar crane of a certain French type the whole load of 39,000 pounds is hung on top of the post and sustained by a ball thrust Fig. 9, making use of 1¾-inch balls. Immediately below it a radial bearing takes the 21,000 pounds of horizontal thrust on 1⅝-inch balls.

The mounting of this paper calender roll Fig. 10 is the first shown in which the load is taken on two rows of balls. The standard practice is to carry all the

* By scaling the drawings we find the balls to be about 50 mm. in diameter.—ED.

load on a single row of balls owing to the virtual impossibility of dividing it with certainty among more. Where, however, a one-sided journal can be employed, as in railway axles, calenders, etc., an equalizer is practicable. In this case, the bearing box is hung on a trunnion (dotted lines) midway between the two rows of balls. The outer races of the ball bearings are loaded on one side only and entirely free on the other. Both will therefore receive an equal part of the load; this distribution will be unaffected by spring of the frame, etc. The arrangements shown will carry a total roll load of 56,000 pounds.

Few mechanisms employ balls larger than these 3½-inch ones that serve to give ease of rotation to a 7-inch naval gun mount, Fig. 11. The steady load carrying capacity of over 90 tons is, of course, far in excess of the weight actually sustained, but is supplied to take care of the shock of firing.

In the domain of electrical engineering flywheel converters used in German mine hoists carrying rotating loads from 4 tons at 1,200 revolutions per minute to 22 tons at 500 revolutions per minute, some on one and others on two ball rows per journal. The arrangements here shown for 22 tons, Fig. 12, is similar to that employed for calenders with equalizer for two ball rows, differing in that the shaft projects through the journal and that the ball races are clamped to the unchanged journal of the old shaft by so called "adapters." Owing to the relatively high speed and necessity for a high degree of safety in this class of service, unusually large bearings are selected.*

In Italy acetylene gas is being used for welding iron and steel in places difficult of access, the gas being burned with oxygen as in the oxyhydrogen flame, but reaching a temperature of 7200 degrees F. in place of between 4500 and 6000 degrees as in the latter case. The process is economical and produces a weld as good as that made by electricity.

FIG. 2

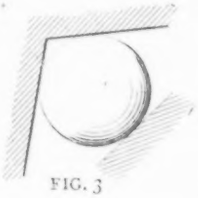


FIG. 3

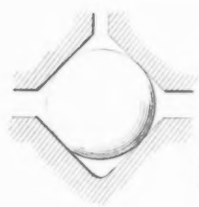


FIG. 4

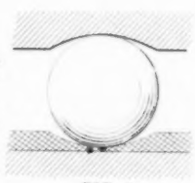


FIG. 5

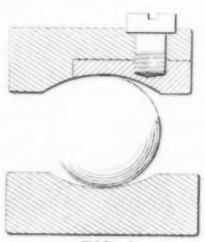


FIG. 6

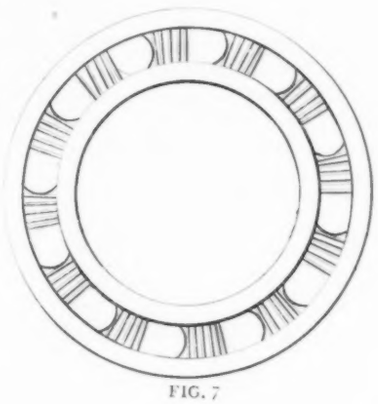


FIG. 7

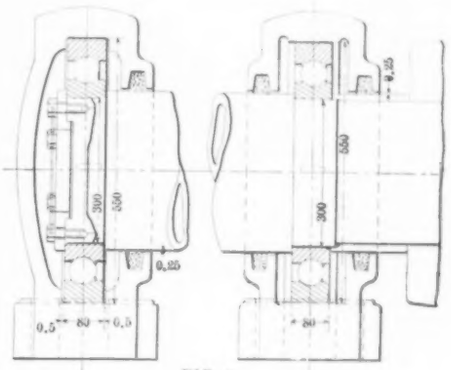


FIG. 8

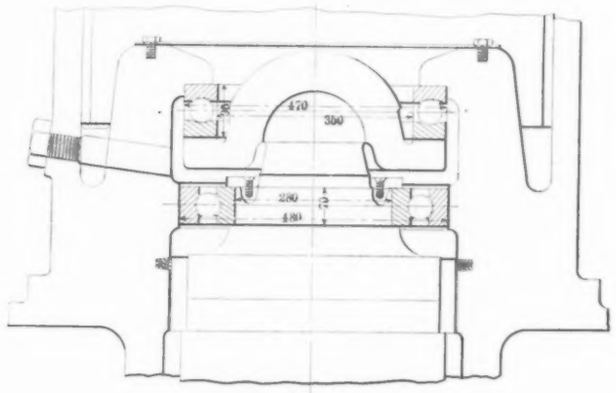


FIG. 9

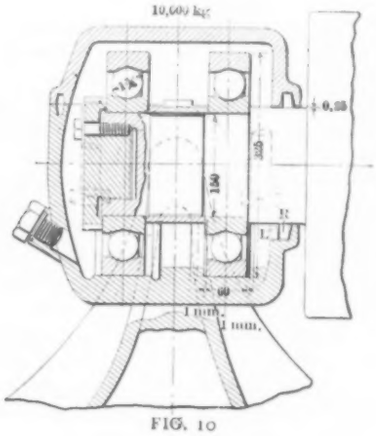


FIG. 10

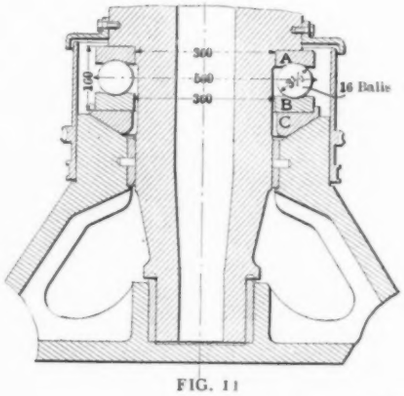


FIG. 11

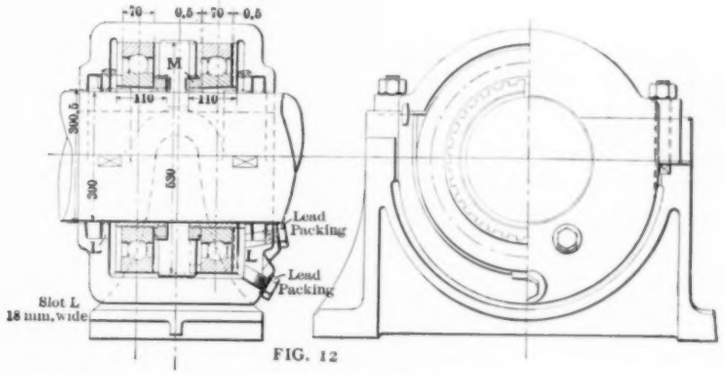


FIG. 12

APPLICATION OF BALL BEARINGS TO HEAVY WORK.

*The use of the scale shows these balls also to be about 50 mm. in diameter.—ED.

Letters to the Editor.

Free-Hand Sketches as Working Drawings—Commercialism and Lack of It—Cost Keeping.

I am getting lazy. Of course you know that much already but on top of such a candid acknowledgment I expect that you will hold up your hands in feigned astonishment. The particular branch of laziness that I am studying on just now is drawing. I like to draw, but my stomach has a decided aversion to the sharp edge of a drawing board, so I like better to sit back in a chair and do my drawing. Then too, I get tired of a job just about when it gets to the point where lots of draftsmen begin to enjoy it—when it is ready to put into final shape. I got over part of my troubles a long time ago by making only assembly drawings and putting all the machinist's measurements on them; but now I have discovered a way that just suits my particular style of laziness. The way it came about was this: We had a planer that was modern quite a number of years ago and we had a lot of work for it. In overhauling it we found that we had enough to work on so that it was going to pay to do it thoroughly and we decided to put on a new cross-rail with two heads. I went to a shop in town where they build planers, introduced myself to the new superintendent and asked for a price on a suitable cross-rail and heads, but found that my appropriation wouldn't cover it. Then I tried to buy castings and blueprints, thinking that as work was a little slack we could build the parts ourselves. He flatly refused on the ground that we could not do the work without special tools which they had and that they did not wish to lend; in fact he frankly told me that I did not know enough to handle the job. This made me feel a little cranky, but I consoled myself with the thought that he didn't know me and he didn't know that I had been a director in his concern before his time as well as being in the dual position of head draftsman and office boy. So I blarneyed him a bit and compromised on a set of castings and no blueprints or tools at any price, though he did offer to take the castings off my hands at a price if we couldn't use them. When the castings got around I was up to my eyes in work, so they lay around till we absolutely needed the planer. Then one Sunday I went down to the shop and made some sketches of the castings just as they were. As I was going home it occurred to me that any sort of a drawing that was reliable and accurate was good enough for that job, so I sat down after dinner and began to draw free-hand on some old letter heads. First I drew a cross section of the cross-rail allowing as much to come off for finish as I judged by my eye was necessary to clean up. Then I took my sketches of the old planer and figured where the feed rack could be easily put and laid out a drawing with compasses and scale, so as to get possible positions for the two feed screws and the feed rod and have a gear run in mesh with pinions on the end of each. This and a layout for the angles of the bevel gears in the heads were the only drawings that I made to scale. From there I went on and before supper I had a complete set of drawings all inked in, that had every particle of information on them that could possibly be asked for by men who were used to that class of work. All that I had to do was to be sure that my arithmetic was good, so that I would not allow more than a 3/8-inch packing to go into a 2-inch opening where the other piece was 1 5/8-inch thick, and so on. Everything on this whole mechanism could be readily worked out in this way and any draftsman would really work that way as he went along, but I tackled the whole job off-hand and brought it through with but one slip, in just about the time that I would have required to get ready to draw in the other way. I inked these sketches, also free-hand, just to keep them from getting erased either accidently or purposely in the shop. The beauty of it was that there was practically no drudgery. It was all interesting work from start to finish. Since doing this job I have kept track to see what can be done and I have noticed that a large percentage of the work that I have run across can be handled that way by a man familiar with the machinery he is working on. If a man wants to see about how his work is going to look when finished he can use cross-section paper to sketch on if his eye for sizes is not to be depended upon.

This is a commercial world. We are all out for the almighty dollar. Every once in a while some of us get worsted in the fight and then we turn around and cry out that the world is too commercial and show our anxiety for those happy days when nobody will crowd anybody else in the chase for dollars. I have spent my last four summers and as much of a winter this year as the calendar allows us in a community where this clash and bustle for the almighty dollar is eliminated entirely. If any of your readers are pining for millennium in this direction I will be glad to put them in the way of advancing a long way toward it. This is a town where only two or three men, who have broken in from outside, care whether they have one dollar or one hundred dollars in their pocket. It is a town where 3000 quarts of milk are produced a day and where if your baby is starving you can't buy a drop or a can, at any price unless you get it out of friendship. It is a town where if you break down and want a bit of harness mended you will be told by the only man in town who can sew leather that you will have to wait till the next warm day to have it mended, and no amount of money will warm the weather. It is a town where everybody raises vegetables but if you are there for the summer, or winter, you must have everything brought up from the city 10 miles away at rates that would carry it across the ocean. It is the kind of a town where, when I wanted a ceiling whitened and engaged a man to do it and waited two weeks for him, he declined to come, "as he didn't know but what they might want him to whiten the vestry of the church and he didn't want to carry his pails back and forth," and after trying to get my roof shingled all summer I finally did get it done because the carpenter's horse nearly killed my wife and myself, and he thought he ought to do something in the way of recompense. When you know the people and they know you and if you or your wife hail from New York (the requisite for the elite) you can get anything done you want provided you are forehanded enough to speak early, but if you have dollars there is no use in showing them. Now my wife was born in New York so I get along nicely now, but if I have got to do business give me the sort of people to do it with who need the money, or think they do. These people all draw pensions, all have little gardens, all are rich, from their own point of view, but they don't know what money is worth. A man who needs money will do what you want when you want it and as you want it, and he will pass that money along to someone who also wants it. "Me for commercialism."

In one of our neighboring manufacturing towns there is a large shop where they have an elaborate system of cost accounting. Now they have set a man to work to find out how much it costs them to keep account of their costs. This suggests to me that we have gone crazy over this cost accounting business. Let us review the matter and see how the thing stands.

Suppose that I foolishly decide to build lathes. Then in a moment of partial sanity I decide to build only one size—18 inch. I hire a room, equip it, hire men and perhaps a foreman, and go ahead and build 18-inch lathes. Now in such a case my ledger or even my bank account tells me all I want to know, with the aid of an inventory occasionally. If I am really making money I know it easy enough. If I am losing it gives me no satisfaction to know that my tailstocks cost me more to build than I think they ought. I can't leave them off. If I know of a place where I can cut the time or the weight of a piece legitimately I am going to do it just as quickly on a piece that is already done at a low price as on a piece that is costing high. Because my cost account on my ledger shows that I am losing money does not alter the price that I can get for a lathe. That is fixed by the avidity with which people are looking for

lathes, and the size of my advertisement, not by my cost plus a profit as lots of people think. And if I am making a profit, no matter how large, I won't rest a minute while there is anything about this lathe whose cost I can cut. So a cost account will do me no good. But suppose I decide that I will build some other machine, say a 24-inch lathe. Then I want to know whether I am making a profit on the 18-inch and the 24-inch alike. If I keep track of the cost of the two and find I am making a profit of $100 on each 24-inch lathe and losing $25 on each 18-inch, then I will surely drop the latter, though my books still show a profit on business as a whole. This is the real excuse for keeping cost accounts, just to see where you are profiting and how much. All this applies to cost accounting as a whole. In this I do believe: keeping track of the labor cost of individual operations and charting them. This gives you a check on men, machines and foreman. You look over your charts and you see a high peak. Investigation shows that the machine needs new belts or that the drill was soft and wouldn't hold up, or the castings were hard. You see a drop in the cost line and you find that an apprentice boy did the job; if you find that the machine he worked on was not too expensive a one for him to tie up you hire more apprentices. These tell-tale curves show so plainly divergence from past records and are so easily kept as compared with the usual cumbrous system, that I should suppose they would be more largely used. Such curves are not apt to be of much use to set time limits for premium or piece work for in such cases it is better to have some one on your own side go through the work and rely on him. All of which leads me to think that cost keeping on the elaborate scale usually followed is unprofitable.

ENTROPY.

A Standard Size Wanted for Business Cards.

I think the article at page 260 by W. Osborne, is a step in the right direction. Business cards should be of a size that will permit them to be filed in a card index; 3x5 inches would be a good size. Standard index card sizes are as follows: 3x5, 4x6 and 5x8 inches.

If machinery and manufacturing concerns would use a standard card as suggested, it would make it much more convenient for users of their product, and at the same time save them much business that would otherwise be lost. As an example I wish to state that two or three months ago I desired to get prices on small steel pins, and after looking through my index and the AMERICAN MACHINIST'S advertisements, I was obliged to write to the AMERICAN MACHINIST asking for names and addresses of concerns who made sepcial steel pins. This example also shows that a business card should state plainly in a general way what a concern has for sale.

The cards of many belting concerns give a price list on the reverse side and thereby save much unnecessary correspondence. As the AMERICAN MACHINIST did much to standardize catalogs, it should do as much for the business card.

HERMAN JONSON.

Things that Are not in the Engineer's Pocket Books and Things that Are Good Enough as They Are.

A few days ago a customer telephoned an order for a forged ring of wrought iron, 9 inches inside diameter, to hoist ten tons by a hook in its upper side and ropes looped into the lower side of the ring. No size for the stock was given; he "wanted it strong enough so it wouldn't bend and pinch the ropes," and he wanted it right away.

With a confidence that was not born of previous experiences I turned to my several pocket-books for a formula to cover the case, and, as usual, could find nothing that fitted it. As it is a problem that must have come up many times already in the experience of chain makers I had hoped to find something bearing on it, but if it was there I failed to discover it. However, in a back numebr of a defunct technical magazine I did find a formula that seemed to be just what I wanted; anyhow I made out the blacksmith's' order in accordance with it and will probably soon know whether it was a reliable one or not.

When I am reading mechanical papers and magazines I keep an eye out for just such bits of information; if the paper is one I do not care to file for reference I cut out the article and put it in my knowledge box. If I file it away I enter the date, page, and heading of the article on a card in that same box. This save lots of hunting when time is precious.

Of course I am making a pocket-book of my own, and already it contains information of value on several subjects that the standard pocket-books either leave out entirely or else give misinformation about. In saying this I speak advisedly, for I have had opportunity to experiment on one or two lines and so arrive at actual results. But as it would take a big book to hold what is not to be found in the standard pocket-books, so there are lots of blank leaves in mine, and this article is written in the hope that some of your readers who have had a chance to experiment along a certain line will help me to fill one more blank page with useful knowledge.

If there is any point in machine design that one would expect to find thoroughly covered by the text-books it is that of journal bearings. It is hard to imagine anything that could be called a machine that would not have two or more journals in its construction. As far as stationary steam engines and locomotives go, the matter does seem to be pretty well threshed out, but when we go outside of these two lines our troubles begin. Unwin devotes 26 pages to journal bearings, and seems to have experimented with a good many kinds of oil, but I failed to find anything that would apply to my case. One of the newer pocket-books publishes a table of journal proportions and on another page advises that the pressure be kept down to 300 pounds per square inch of projected area. This agrees with the table about as 4 is to 10. Unwin seems to have made most of his trials with a journal flooded with oil, something not common outside of a few special lines. The journal that I was concerned with is turned from 3-inch steel, runs at 1,500 revolutions per minute, and is lubricated by a strip of tallow fat laid into a long slotted oil cup and probably drenched with machine oil. This may sound primitive but in the midwinter atmosphere of a sawmill located up Labrador way it has been found to give better results than any other mode of lubrication.

So many wood-working machines have been built with bearings of this sort, and they have generally given such good satisfaction under the unfavorable conditions that surround them, that there may not have been much incentive to get at their scientific requirements, but if anybody who reads this has been able to locate the true formula for their proportions I hope he will send it in for the benefit of his fellow men.

My old boss used to say, "It is all right to guess if you only guess right," and in guessing at the length of that particular journal I am confident I guessed right, but it was guess-work and nothing else, except as my guess was influenced by an experience on similar machines that had gone before. One reason why I am confident of this is that we have a good many of these machines out and until now have had no complaint from hot-boxes. Furthermore, a duplicate of the machine that heats is running in another mill with perfect success and doing considerably heavier work and more of it. From this it appears to me that somebody has it "in for" that particular machine in that particular place and I have no idea I can say or do anything that will make it satisfactory to him, but if a scientific basis for designing such bearings has been discovered I am on a hunt for it for my own gratification.

I am tempted to give a list of the common things of mechanics that I have not been able to find given any satisfactory attention in the various engineer's pocket-books. My wife has a large and comprehensive cook book which, so she tells me, never happens to hold the particular

recipe she is looking for at the moment, though it would seem to contain about everything else in the way of information that the culinary art could need. I tell her it must have been compiled by some author of an engineer's pocket-book (or his wife) for none other could have so perfectly duplicated the scheme on which these works are planned.

Among the things I should put in such a list a prominent place would be given to paper and iron friction wheels, both spur and bevel, horse-power of manila ropes, minimum diameter of sheaves for same, ditto for wire hoisting ropes, and proportions of hoisting hooks. All these are common things, in everyday use, with abundant opportunity for experimenting and I have had a chance to find that the published data on them all disagree woefully with actual practice. The friction wheels will transmit much more power than they are rated at, so will the manila rope; hook formulas are "way off" and we are successfully running hoisting rope over sheaves less than a third the sizes recommended as a minimum. If we made them larger the ropes might last longer. Probably they would, but they last *long enough*, and that is the point of importance. Can you imagine a boom derrick carrying a 1¾-inch steel hoisting rope passing over a sheave 11 feet in diameter at the tip of the boom? Well, that is the minimum size the books give for a rope of that size. The sheaves we send out are a great deal smaller but in all the years we have been building these derricks I do not recall a complaint of sheaves being too small, so I feel warranted in saying the sizes we use are within the limits of good practice. When a thing is *good enough* that is the end of the matter.

This fact was hammered home the other day when I was looking at an old machine of another firm's make which had been sent us for a general overhauling and repairing. For raising and lowering the heavy platen there was an internal and external gear, apparently cast in one piece, with a pinion shipping from one to the other. The smaller diameter of the internal gear giving a faster speed for lowering than for raising, the power was very equally applied, but the pinion ran at a good speed and the work was heavy and I fully expected to see those gear teeth come out by the roots when it started up for trial. Except for a chattering growl at the moment of starting it worked all right.

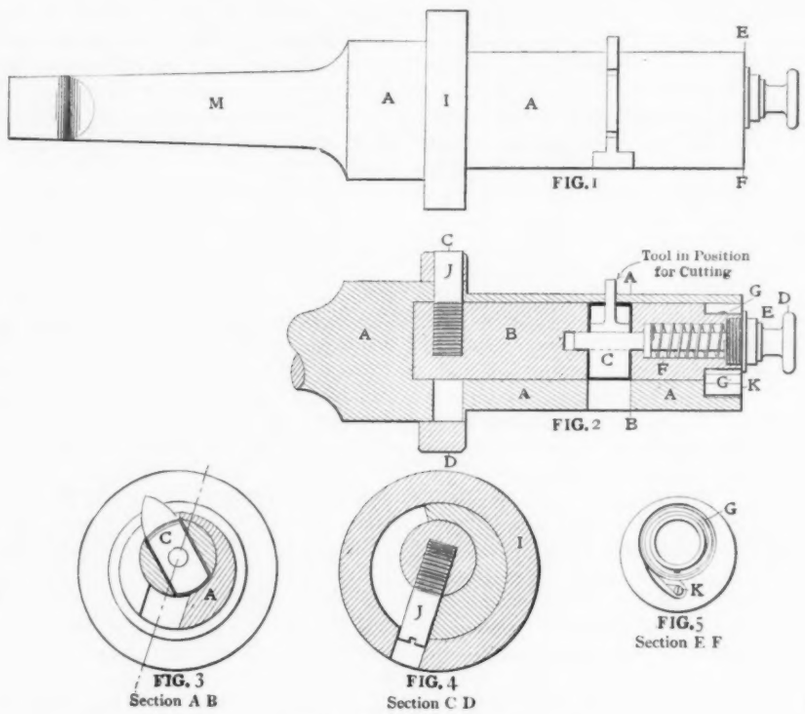
On another make of machine, and for operating the same sort of a platen, there is a nice arrangement of friction clutches that cost four or five times as much as the rig just described. It operates without any chattering or growling, but as the cheaper rig was in good order on a worn-out machine I was forced to conclude it was plenty good enough.

E. R. PLAISTED.

Automatic Flue-Cutter.

At the present time there are a large number of machines used for cutting out the flues in a locomotive, which are removed in the course of repairs to boilers and fireboxes. Most of these flue-cutters are operated at considerable expense and loss of time, while a few may be said to be very successful both as money and time savers.

The accompanying illustration shows a flue-cutter designed by T. M. Vickers, general foreman for the Atchison, Topeka & Santa Fe Railway at San Bernardino, Cal., and constructed in the tool-room at that point. A somewhat similar machine was built by Mr Vickers while holding the position of machine-shop foreman in the Cleveland shops of the Lake Shore & Michigan Southern Railway. This machine, however, required a reversible air motor, there being no automatic tool release as on the present machine.



AUTOMATIC FLUE-CUTTER.

With this flue-cutter one man can cut out from 200 to 300 flues per hour, while the highest record by an experienced man was a set of 280 flues in 25 minutes.

In the accompanying drawings, Fig. 2 represents a longitudinal cross-section; Fig. 3 a vertical section at *AB;* Fig. 4 a vertical section at *CD,* and Fig. 5 a vertical section at *EF,* showing the position of motor spring *G.*

A represents the outer shell or body, being furnished with a Morse taper shank of suitable size, by which it is attached to the driving machinery. *B* is a cutter bar for holding the cutter *C*. *D* is a cutter-retaining plug fitted with nut *E* and the spring *F,* and holding cutter *C* in cutter bar *B*. *G* is a motor spring and is used to bring the cutter and bar back to normal position when pressure from cutting flue is off the cutter. *I* is a collar journaled on *A,* connected to cutter bar *B* by a screw or dowel *J*. *K* is a screw which anchors motor spring *G*. The cutter *C* is drilled to admit cutter-retaining plug *D*.

In operation the cutter *C* is brought to the normal line *H* Fig. 3 by tension of motor spring *F,* receding slightly below the surface of *A,* by reason of its journal being eccentric to *A*. The tool in this condition is ready to be inserted in the flue which is to be cut. Once in motion, a slight pressure is put on the collar *I* by the hand of the operator when the cutter passes through the flue, and with one revolution makes a clean cut. Should the cutter become dull or broken it can be immediately removed by pulling out the knob *D,* and a new one inserted with very little loss of time. After completing a cut the cutter is immediately brought back to its normal position by spring *G*.

G. E. B.

Brazing Gray Iron.

At page 183 you published further information on this subject. I am a metal pattern maker and that was useful knowledge to me. I followed the directions and after several failures finally made a successful joint. The secret lies in the slow and continued heat before the borax and filings are applied.

CHAS. A. RICHMOND.

A Driving Box Square.

The accompanying illustrations show a very handy and necessary device for use about locomotive repair shops. It is used in squaring the spring saddle seats which are located at the top of the driving boxes as shown at *A* Figs. 2 and 3.

Fig. 1 is a detail drawing of the square while Figs. 2 and 3 show it in position on the driving box. The square proper is made of ¼-inch machine steel, while the feet *B* and *C* are also of machine steel turned to the required size and shape. The feet are held in position by thumb screws and are prevented from slipping off the end of the bar by a small pin *D*.

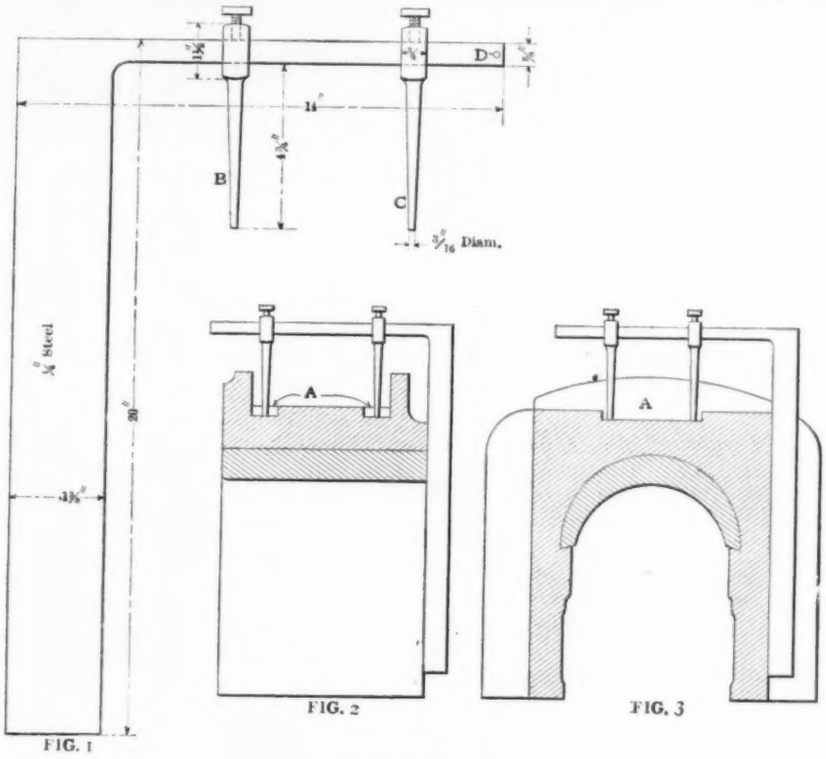


FIG. 1 FIG. 2 FIG. 3

A DRIVING BOX SQUARE.

This device was originated by W. A. Roberts, machine shop foreman for the Santa Fe Railway at San Bernardino, Cal., and has been in use for some time at those shops. G. E. B.

Reading the American Machinist.

Referring to Konstant Reader's article at page 223, concerning the reading of the AMERICAN MACHINIST, I may say that I am a machinist, and therefore debarred from reading my copy during working hours. I read mine at home on Sunday, reading it straight through, and then going back and reading the "harder" parts over. To me the harder parts are the theoretical, as I am so far merely a practical man. Then I take my little "good thing" book and copy any little drawing or article (useful in my practical way) in it. It is indexed, and has several times proved its worth. As for the advertisements, I have heard several fellows say things about catalogs, and buying a lot of advertising, but to me they are half the interest, not only as serving to show the evolution of certain machines, but to broaden the knowledge of machinery in general. This subject is very interesting to me, and I for one would like to see it discussed.

Canada. W. L. McL.

Friction between the Shop and the Drawing Office.

There seems to be, in many establishments, a constant quarrel between the shop and the drafting room. It has existed since shops with drafting rooms began to exist. When a blue-print comes into the shop it is immediately picked to pieces. "A fool would know enough to step that shaft and this dimension should be shown there instead of here. This dog should be tool steel and not machine steel case-hardened, and that wearing plate would be well enough held with screws without that key." And if a mistake is found, no matter how trivial. "!!!"

The criticism may not be true. Often enough it isn't; or it may be true, but sometimes there is something truer than truth in dealing with men, and that is to be sure your criticism is intended not merely to irritate or find fault, but to really make the machine better or cheaper or to increase its usefulness.

So much for the shop.

The drafting room also can do something toward lubricating the troubled waters, if so mixed a figure may be used.

Unfortunately it is very rarely the case that a draftsman has had absolutely good shop experience in spite of his "front;" and, not infrequently, the shop foreman could "shut the eye" even of the chief. Even if he cannot, errors will creep past the most watchful designer's or checker's eye, and it is rare indeed that a good mechanic cannot point out something in a new machine over which another man has rubbed his head for many a long hour that would not be a little better made a little differently. No matter how great care is exercised on the drawing board, some of the changes that are sure to be made before a complicated machine is ready for the shop will leave some mark somewhere, perhaps in a bracket made less simply than it could have been, a slide larger than need be, a cap-screw where a bolt would have been better, or a movement used that could have been more simply arranged.

And why should not the drafting room admit to itself this plain fact and not consider that it is "*the* brain department." If it isn't *a* brain department it needs a house-cleaning; but there are other departments with gray matter lurking around in somebody's head. So take it kindly when a suggestion is made for a change. Make the change, if it is a good one, and acknowledge it was good; and if it isn't, take the trouble to explain why you think it is better left as it is—always with due regard for the man who argues for exercise. Don't feel sore that somebody finds faults in your work. Doesn't it almost always happen when the shop foreman comes with a machine or jig or something that he wants a drawing made for that you can suggest a change for the better? Your brain comes to the problem fresh, while his is full of the fag ends of the wrong thoughts that come before the right one. It is no reflection on him that you can do this (though it is on *you* if you can't do it tactfully). No more is it on you that he can see changes in your work that would improve it.

And then he *cannot help* finding the errors. He makes them in cold, hard metal, and when two bodies try to occupy the same space simultaneously they announce the fact promptly. On the drawing board it is different.

And please note that he actually does make mistakes many a time before he sees them. And he makes more besides—only you do not happen around to see them, and he does not usually feel called upon to come up and tell you when a small change can be made that will cover it, or when a convenient dark corner under the bench is available as a remedy.

Mechanical men seem sometimes to forget that in some ways men handle differently from steel. You can harden them and they will make the sparks fly, and you can anneal them; but with steel it is a heat treatment. With men it isn't.

MASON.

Milling Steep Pitch Worms.

Since writing about the use of a thread-milling machine, as published at page 58, Vol. 27, I have made some experiments cutting a worm on this machine, and as the results are rather interesting and

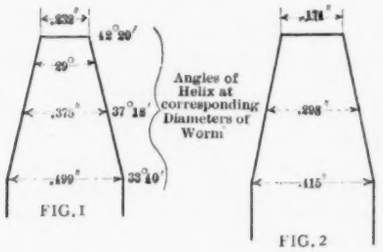


FIG. 1 FIG. 2

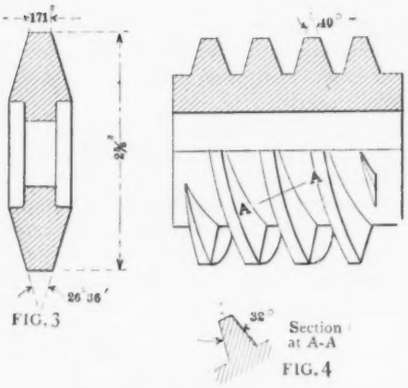


FIG. 3 FIG. 4

MILLING STEEP PITCH WORMS.

show the conditions that arise in cutting multiple threads, I have kept the exact figures used and give them below with the result.

The worm to be cut had 8 threads of ¼-inch circular pitch, 6 inches lead, 3348 inches pitch diameter, and 3825 inches outside diameter.

A rack tool for this pitch would have the dimensions given in Fig. 1, and the worm angles would be as marked on the tool. On this basis the corrected cutter outline was determined, as in Fig. 2. The cutter for the milling machine was made to correspond with Fig. 2, the top and bottom figures being used, and giving a cutter as outlined in Fig. 3.

We milled our worm, setting the milling cutter at the pitch diameter angle of 37° 18′ as nearly as possible. As the cut proceeded it was soon apparent that something was not right, as the top of the worm teeth seemed too narrow. This turned out to be the case, as the helix was so decided that the cutter was generating quite a different profile of tooth from the standard. It looked as if it would have been more nearly correct to have set the cutter at a smaller angle, but this would probably have cut the space at the bottom of the teeth too wide. After finishing the cuts the tooth angles in line with the axis were 40 degrees and at right angles to the thread 32 degrees, as shown in Fig. 4.

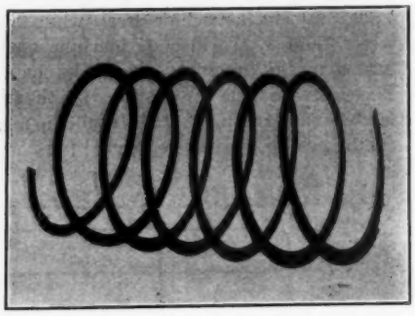
This goes to show that it is impossible to mill a worm with a rotary cutter intersecting a very pronounced helix and get the space correct, unless this interference is corrected by thinning down the cutter.

E. J. Lees.

Re-cutting a Stripped Thread in a Nut at Sea.

There is an old saying that "misfortunes never come singly," and the engineers of a twin-screw Atlantic liner thought that they were getting a practical demonstration of this during one of their west-bound trips this winter. The ship had been plowing her way through mountainous head and bow seas ever since she cleared the Scilly Isles, and the steering engine had been either throwing the rudder hard over, or rattling across from port to starboard and back again for several days in a strenuous attempt to keep the good ship on her course. When the sea kept steadily on either bow for some time, the screw on the weather side would be driven faster than that on the lee side to assist the action of the rudder. Even with this assistance the tiller would be traveling to and fro with a frequency which gave point to the caustic comment of one of the enginers: "I wonder if that fellow at the wheel thinks he is sculling the ship; there's no gear ever made will stand that sort of treatment for any length of time."

That his remarks were justified was shown shortly afterward, when one of the steering engine crank-shaft bearing studs snapped off, and the hand steering gear had to be used while the engineers drilled out the broken stud and fitted a new one. While this work was going on the steering was assisted by slowing down or reversing the lee main engines every minute or so. This necessitated rapid handling of main engine stop valve for several hours. Just before the steering engine job was finished, the main engine stop-valve refused to answer the wheel. Upon examination it was found that the



THE STRIPPED THREAD.

screw in the brass nut at the end of the lever had stripped, and was clinging to the screw like a spiral spring. The screw was 2¼ inches diameter, with a square thread 3/16 inch pitch. The valve was 14 inches diameter, and the pressure 200 lbs. per square inch, so that the load on the valve was 30,800 lbs. The valve complete weighed about 700 lbs. The valve was of the balanced type and was easily worked by the hand wheel, which proved that the balance was in good order, and this was also shown by the fact that the thread which had carried away was worn down to about .020 inch in thickness.

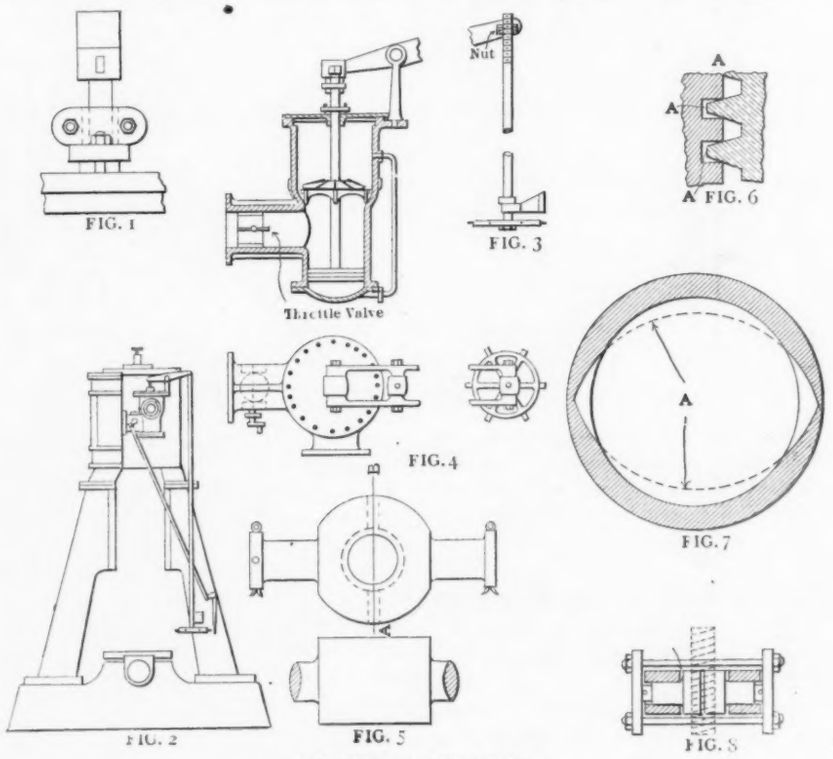


FIG. 1 FIG. 3 A FIG. 6 FIG. 4 FIG. 7 FIG. 2 FIG. 5 FIG. 8

RECUTTING A NUT AT SEA.

In ships of this class, there is usually fitted a throttle valve of the disk type, which controls the flow of steam but is not steam tight. This valve is normally operated by the governor, but can be operated by hand if necessary, in case of the governor gear or main stop-valve becoming defective. This throttle valve was used on this occasion to work the engines until the engineers were finished with the steering gear, the main stop-valve having been gagged full open by a clamp around the stem outside the cover gland Fig. 1. The engine, with throttle and stop-valve connections, is shown in Fig. 2. Figs. 3 and 4 show the valve chest. It will be observed that the stop-valve stem has a slotted crosshead which allows the lever pin and block to describe the arc due to its travel, but at the long end of the lever there is no provision for this movement, as the length of the rod permits it to incline or bend slightly, and there is also a little play at the collar on the lower end of the rod where it is supported on a collar by a bracket on the column. This construction keeps a certain lateral pressure on the screw, and may account for the wear on the screw not having been observed before this time.

After the steering engine was fixed, the engineers started on the main stop-valve job by taking off one side of the lever and backing off the other side far enough to admit of the removal of the nut. There was still a faint trace of the thread left in the nut, and after considering various schemes, the engineers decided to cut a new thread in the nut by hand. I might mention here that the nut was 3 inches deep, and is shown in Fig. 5. The nut was sawed down through the line *AB*. Two of the assistants took one-half each and cut grooves on the trace of the old thread tapering from ⅛ inch at the side to 5/16 inch in depth at the center, and ⅛ inch broad at the bottom to ¼ inch at the top. These grooves were roughly of the section shown in Fig. 6. When the halves were tried on the screw and tapped lightly on the back, they showed plainly the inaccurate parts of the new thread. These were removed with a side-cutting chisel and smoothed off with a file. Then the thread was filed and chipped off at *A*, Figs. 6 and 7, from ⅛ inch at the center. 5/16 inch was cut off each half nut at the parting shown dotted at Fig. 5. The nut was then oiled and dusted with emery powder and replaced in the lever, which was disconnected at the stop-valve. The other side of the lever was also put in place, and the nut slipped down to the lower part of the screw which was not required in operating the valve. A clamp (made from the safety-valve gags, used when the boilers were undergoing their annual hydraulic test) was placed over the lever to bind the half nuts on to the screw Fig. 8. The screw was then turned by the hand wheel for about an hour and a half; the clamp being tightened up as the nut bedded to the rod, until the faces came together. It was then examined and found to be a good fit. Fig. 7 shows the area of the new thread in comparison with the original. After cleaning the nut it was replaced and the gear connected up. The engines were then stopped and started with the stop-valve and all found to work satisfactorily, the whole job having taken about eight hours. Fig. 9 shows the thread of the stripped nut.

J. R. M.

The Device That Failed is a Failure.

It is very queer that so many do not understand the reason why the device that was a failure—described at page 506, Vol. 28, Part 2—failed. The problem that was to be solved was *not* to drive the mandrel, *but to save time over the old way of turning the pistons.*

In my article I told the story of the failure of the device as far as it went, but I should have added that several ways were suggested for driving the pistons, one of which was the one illustrated at page 884. These were not carried out, as it was demonstrated that the driving of the pistons was only *one* of the defects of the device.

Turning one piston at one time, using a very short mandrel, with a square end for the driver—that was driven in the taper hole by a blow of a copper sledge hammer—it was possible to take one roughing cut 3/32-inch feed, 30 feet per minute, and one finishing cut ½-inch feed 30 feet per minute. As the part to be turned is only 1⅛ inches, that is 2¼ inches in all, a little calculation will show that in the case of a 20-inch piston the actual time spent in roughing the piston was little over four minutes, say five, and one minute for finishing it.

Even an apprentice will understand that taking four cuts with the above specified feed and speed is out of the question, especially in the case of the pistons, the taper hole of which is only 1⅝ inch at the large end, even by driving the pistons as shown at page 884.

Lighter feed or more than one cut would mean no saving of time over the old method. After taking the roughing cut the heavy multiple tool-post had to be removed to give the finishing cut, the same as when turning one piston at a time. I refer now to the tool-post shown at page 506.

To drive the mandrel in the taper hole and release it, two blows with a copper sledge are required. Consider the time spent in screwing and unscrewing the nuts of the double mandrel to secure and release the pistons and the two special tap-bolts, in handling the heavy tool-post, and in setting the tools to cut the right diameter every time they had to be sharpened, and see whether it was ever possible to save time over the four or five minutes required to rough down one piston in the old way.

I stated before, and claim now, that the device that failed transformed an easy job that could be handled in the ordinary way with speed into a difficult and long one, on account of the lack of stiffness of the mandrel and the nature of the machining operations.

"A Britisher" used separate tool-posts that can be set at any distance required. Will he oblige me, and, I am sure, many other readers, by giving a description and sketch of his tool-posts? How did he take the finishing cut and fit the rings in the pistons? Is he sure that his method of turning the pistons is the *quickest* and best?

JOSEPH M. MENEGUS.

Repairing Cracked Water Jackets.

The repair man's harvest from frost cracked water jackets of gasolene-engine cylinders is now about due.

The forms of cylinders are so varied and the ruptures so apt to come in the most inaccessible places, that special treatment is likely to be required for each case. The repair of such cracks is liable to be somewhat bothersome for the reason that they are not generally open enough to allow the introduction of any cement; and, as they do not absolutely prohibit the use of the engine, it is sometimes difficult to induce the owner to wait long enough to get a good job.

An excellent cement for the purpose is made by intimately mixing 60 parts, by weight, of finely sifted cast-iron borings with 2 parts of sal-ammoniac and 1 of flowers of sulphur, and working it up into a thick paste with water.

It is well to make a tool, by grinding off the end of a three-cornered file, and to trim off the outside corners of the crack to a V shape, then tamp the mixture in as far as possible, filling tightly a little more than flush with the outside surface, packing well and pressing down firmly by clamping on a piece of wood.

After it has been allowed to set for 24 hours, smooth off the outside and give it a coat of good, heat-resisting paint.

If the crack is a large one and liable to spring open when the cylinder becomes heated, it is well to apply one or more hoops in such manner as the location of the crack and the form of the cylinder will permit, making them in halves drawn together by bolts, and applied after the cement has been worked into the crack.

If the job is a hurry one and a neat appearance not especially desired, after tamping in the cement and spreading it liberally on the outside, a piece of band iron may be clamped over the breach by placing it under the hoops, and the job

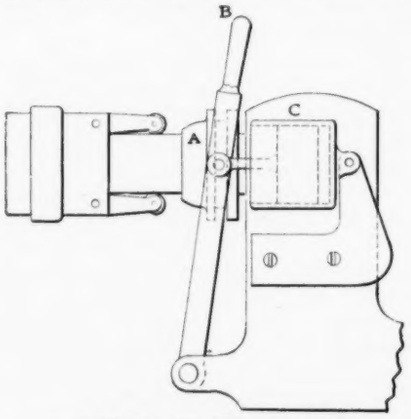
will be ready to use after standing over night.

In case of such a job as this, the iron patch may be coated with wax or tallow; and, after a few weeks, or whenever time permits, it may be taken off, the cement smoothed down, and a coat of paint applied as before mentioned, making as neat a job as could be desired, while it will ordinarily be firm enough to withstand breakage through expansion by heat.

W. D. GRAVES.

A Dash-Pot on the "Automatic."

I have had a little trouble with the chuck operating mechanism of a well-known type of automatic screw machine. I am not finding any fault, or offering any criticism, as the machines referred to have performed their duty exceedingly well, in fact doing better than their makers guaranteed by a good margin, even when carbon steels were used; but recently steel improvements (which came after the



A DASH-POT ON THE AUTOMATIC.

machines were installed) have made it necessary to grip the stock tighter than was originally intended.

The mechanism for operating the chucks is well designed and well built, and works freely. The extra strain we have been obliged to put on it causes the cone *A* to release with a blow a little short of one produced by a sledge-hammer, and the flat springs originally intended to cushion the stock proved unequal to the task, and the handle *B* would break off at the neck. This was due to the shock caused by the cone striking the end of the spindle bearing. To overcome this difficulty I fitted a short dash-pot as shown. The pin in the arm which carries one of the rollers which work in the groove in the cone was removed, another pin being fitted, and extending out from the arm about two inches. The piston of the dash-pot was pivoted to this pin, a bracket fastened to the head block carrying the dash pot. The bottom of the dash-pot has a ⅛-inch air cock so any desired amount of cushion can be obtained. The dash-pot, piston and bracket are of gray iron.

This device has been in use about two years and has worked perfectly so far.

LEROY TABOR.

Shop Suggestions.

We hear the shop-suggestion scheme eulogized and condemned. As adopted in some places it would seem to be a good thing, and possibly many establishments using the idea have found it so.

I have been personally acquainted with the plan in several manufacturing concerns and cannot from my observations speak well of it. The conclusion has been forced upon me that in general it is detrimental to both the company and the employees who become victims of the suggestion habit. As generally introduced it allows all the employees to compete and, as compensation is received for an idea or suggestion, in many cases it marks the beginning of the man's uselessness as an employee in his legitimate line of work. A great many are prone to the "swelled head" and it requires only a little encouragement of this kind to fully develop the malady. I have seen some good workmen go down and out after they had received their first compensation for an idea or suggestion. Their regular work was slighted in the pursuit of invention, which, as a regular business, comparatively few are qualified to engage in.

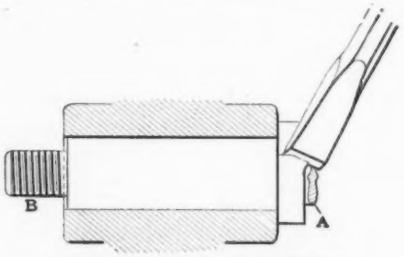
Again, it is the cause of a deal of rivalry between employees and their foremen as well as between the foremen and heads of department themselves. Each and all are looking for the "honor" and cash bonus, and petty jealousies, underhand work, bad feeling, discontent, too much indulgence in "sore head" talk are factors that seem to be attendant upon the shop suggestion plan and the company has to pay for all of this and the cash bonus in addition. The temptation to some men in authority to avail themselves of any possible benefit that might result from the inventions or improvements of the men under them, is often too great for their scruples and the many subterfuges possible to practice upon an unsuspecting and may-be too confiding employee, by a foreman or other officer who is supposed and surely ought to be, above such meanness, are brought into requisition and in many cases the inventor is done out of his idea. It is easy to assure him that you have a modification of that idea, made some time ago, and in proof of it you show him a sketch to prove what you say, at some convenient time subsequently, or you can assure him the idea is of little value and kindly steer him off onto something else by giving him a suggestion or two that of course will be of little benefit to him. You are now at liberty to sketch up his ideas and modify them so you can appropriate them and bring them out later on and get all the credit and bonus yourself.

Some of my readers may accuse me of exaggeration or "straining at a gnat," but I can assure all such that this state of affairs is attendant, more or less, upon shop-suggestion plans as generally inaugurated and practiced. I am in doubt as to whether this scheme pays or not. It is a subject upon which I have seen very little if any data or comparative analysis. My deductions are simply based upon my observation and long association with shop matters and I am yet seeking information. I favor the practice of recompensing the employee for his ideas if of value, but how to do it in a satisfactory manner and preclude the possibility of the foregoing disagreeeable features and yet encourage the man, I have not found out. I am inclined to believe that the concern employing regularly salaried brains for the invention and improvement of the product has the advantage over those following the suggestion method. Possibly some of your readers who have had the plan in actual operation can throw some valuable light upon the subject, and I am sure it would be appreciated by many.

I. N. EARNEST.

Getting Broken Taps Out—Starting an Obstinate Stud.

At page 159 J. Schuring shows a broken tap, and tells us how two work-



STARTING A STUD THAT STUCK.

men got it free without mishap. The scheme reminds me of a trick once worked by Henry Green, to free a fractured stud that struck a Hartford screw machine. The sketch herewith will show the stud with broken end at *A*. The body was a perfect fit and driven in to stay. The shifter lever for the belts upon the driving cone, swung on this stud until it seized and twisted off as shown. John Handy, when the lever dropped, removed the nut from *B*, and then essayed to start the stud but could not get it free. He tapped it lightly; hit it hard; that fit withstood the shock, although he tried to coax it with a length of cold rolled stock. So Henry Green was called upon to do his level best; he took a heavy hammer and a chisel from his chest, then crawled behind that screw machine and swung his hammer hard, while the chisel bit the metal, but the studlet wasn't jarred. While Henry used his chisel as the drawing plainly shows, he asked the handy man in front to strike a few more blows. Now, pounding both in unison, the stud was gently urged to leave its seat and thus it most reluctantly emerged. After which Henry made a new one to replace it.

Z. Z.

Boring Fixture for a Four-Cylinder Engine Casting.

The horizontal boring mill on which the fixture shown in side view at Fig. 1 and end view at Fig. 2 was fitted with a rotary table, in order that while one casting was being machined another could be set up in position, ready to be swung around to receive the cut. This was quite a saving as the castings being bulky and difficult to handle, took almost as long to set up as to machine.

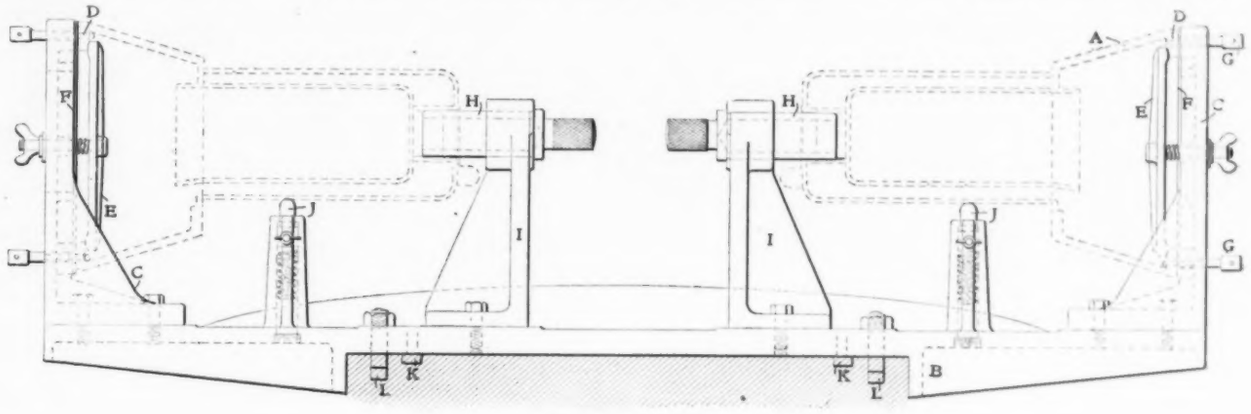


FIG. 1. SIDE VIEW.

As our cylinder casting *A* was a long one, when two were positioned back to back as shown, there was considerable overlap on the table; this, as the castings had to be most rigidly held, accounts for the strongly ribbed construction of the base casting *B*, and the gray-iron angle plate *C*. One of the first operations on *A* was to drill the dowel holes *D*, these serving as locators for all subsequent operations, and also for correctly placing the engine on the car. Drawn up by the clamp *E* against the machined face *F* of the angle plate *C*, and located by the dowel plugs *G*, which passed through tool steel bushing in *C*, the casting *A* received further support by means of the hardened and ground steel plugs *H*, which were suported by the gray-iron brackets *I*. They entered holes which had previously been drilled and reamed in *A*. The spring plungers *J* not only absorbed any vibration which might be set up while boring, but also served as a central support. This was absolutely necessary, as otherwise, should the plugs at either end be withdrawn without due precaution either the remaining plugs or the cylinder would be distorted or broken. The complete fixture was located on the machine bed by means of the pegs *K* and held down by the bolts *L*.

C. F. H.

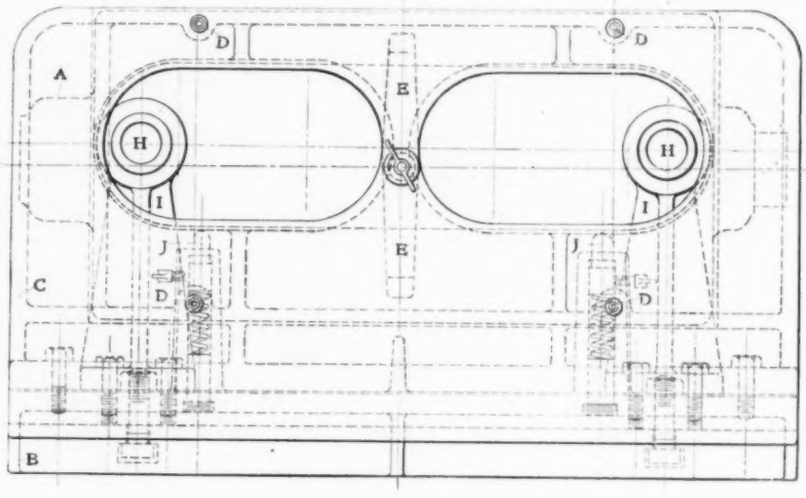


FIG. 2. END VIEW.

Putting in a New Crank Pin.

We were called upon to put a new crank pin in a large engine that was in use, as the old pin had worked loose in the crank disk. We prepared a piece of steel for the new pin beforehand in order to obviate unnecessary delay. We were disappointed in our hope that the hole would not have to be bored, as upon removing the old pin we found that the hole would have to be trued up, in order to be sure of a good job. We fitted up a boring rig, composed of two flat plates, some blocks, bolts, and a bar, one end of which was threaded 20 threads per inch, for about six inches. This fitted a threaded hole in one of the plates. The other plate had a hole bored in it, a running fit for the smooth part of the bar. The plates were bolted to the crank disk, one on each side, the bar run through them; with a suitable tool in it and with a stout crank on the end, a light cut was taken through the hole. One cut was sufficient to insure a nice true hole, great care having been exercised in setting the bar square with the face of the disk.

One of the best men in the shop was given the job of finishing the pin, being told to make it a hard drive fit. The boss was confined to his home by the first day's sickness he had experienced for twelve years, so the entire responsibility rested with this man. The pin was finished in the evening, and the boss met the man, the pin, and a heavy sledge, at the engine room the next morning at seven, as he wanted to see the pin go in. It went in all right—slid half way to the shoulder by hand, and one light clip with the sledge sent it home.

The boss looked at the man, the man looked at the boss; most of you know how they both felt. Now the boss had seen this man make fits—lots of them, but usually on very small work. He had confidence in him, or someone else would have been put on the job. There was a reason for this misfit but it did not crop out till a few hours later. The same man was started on another pin, his face wearing a troubled look all morning. At noon he had the pin completed except for the finishing cut on the inside end. It was then so hot that it was handled with difficulty. Just as we shut down, the boss said, "you had better take it out of the lathe and put it in that pail of water while you eat dinner, so you won't get slipped up on the fit again." The man started. "Well, by Gad!" "What's the matter?" "That's where I fell down on the other one!" He had not taken expansion into consideration.

Now if the boss had not been there

the result would have been something like this: The pin would not have fitted quite as tight as he thought it would, due to the temperature lowering while on its way to the engine, and after it was driven in, it would have shrunk still more, and later would have worked loose, and the reputation of the shop would have suffered. CHAS. A. TRASK.

Michigan.

Some Comments on American and British Ideas and Methods.

It is perhaps more than a dozen years since the AMERICAN MACHINIST came to my notice, since which time its perusal has not been neglected. The interval has been sufficient to permit a number of changes or tendencies in modes of thought, on both sides of the Atlantic, to develop somewhat definitely. As a boy, I remember my family regularly receiving copies of a New England newspaper, *The Woonsocket Patriot,* then colloquially known in Providence, R. I., as "The Old Pat." As I remember, its contents were distinctly good; but I have not forgotten how consistently and quite in good faith, it always spoke of the "pauper labor" of Europe, when touching on industrial topics. It must be at least two or three years since I noticed in print any assumption of all-around spueriority of American—United States—labor and industrial conditions as compared with those of Europe. This is just possibly due to more extended travel on the part of Americans, and the fact that European industrials have proved capable of assimilating in good time such measure of American methods and ideas as they consider helpful under their own special conditions. Another point most Americans, years ago, were quite sure of was, that the opportunities in the States for individual advancement and the individual intelligence of American workmen were of such an order that there was neither need nor likelihood of the establishment of trades-unions on British models of organization and aspirations. Time, however, has introduced us to such trades-unions established in the States, whose rules and methods apparently go not one, but several better than their British compeers, while simultaneously the more responsible unions in Great Britain have broadened their conception of their duties and privileges, and at the same time increased their legitimate influence.

Another subject in the treatment of and attitude toward which change is noticeable, is that of apprenticeship. Until recently, very free and easy views as to the necessity of definite training in the acquisition of trade or craft skill would appear to have prevailed in the States, only a few concerns seriously considering the matter: but it is becoming obvious to a greater and increasing number of American employers that a three or four years' sojourn in a workshop or series of workshops does not necessarily bring out craft skill to the same average extent as the European system of five to seven years. This is particularly the case in some branches of foundry work. While European practice has outwardly altered during the last number of years—written and signed indentures largely being dispensed with—the spirit of apprenticeship has still existed on the part of employers to a quite respectable degree, and within the last year or two commendable efforts are being made to place really useful facilities for day and evening technical education within reasonably easy reach of earnest recruit mechanics.

Regarding the evolution of machine tools, such legitimate criticism of American practice in tool design as has recently appeared from, say Mr. Fish or Professor Sweet would, some years ago, hardly have been so patiently tolerated, or even respectfully received as at present, as witness the hub-bub in 1895, when Professor Sweet ventured to suggest there might be some good points in British design and practice. Our old friend, the gap-bed lathe, has received sentence of death times out of number, but instead of obediently retiring, has found its way into more than one American catalogue, and as I write an advertisement of a gap-bed *grinding-machine* is at my elbow. If authorities on grinding practice can satisfy themselves of the feasibility of gap-beds for grinding, the production of a good gap-lathe for general utility service does not appear quite hopeless, and evidently fills a gap—no pun intended.

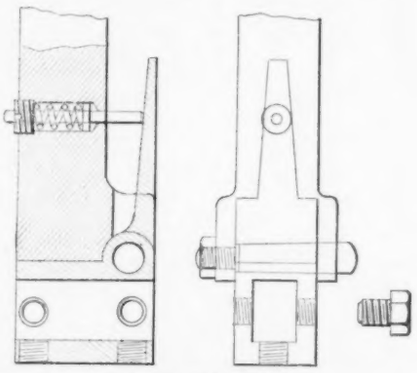
Touching on the engineering of visits to engineering and other establishments as discussed at page 828, Vol 28, Part 2, such visits on this side are by no means confined to the members of the principal engineering societies, but are taken part in by numbers of students' societies, also such visits often form an integral part of the course of instruction provided by the readers of science subjects, and at least one trades-union—of engine-tenders, firemen, etc.,—arranges for Saturday afternoon visits to the principal works within a radius of say 50 miles from headquarters. Further, the office and works staffs of many concerns interchange informal visits in cases where the mutual interest in such matters is sufficiently strong, and it is becoming quite usual for the representatives of prominent manufacturing concerns to receive and accept invitations to read papers before students' associations on their respective specialties. In the management of such visits there is certainly room, as you suggest, for the exercise of skill and resource in the way of insuring that the maximum of information be received by the visitors, and also that in the long run the concerns visited gain rather than lose by their hospitality, if only in the way of mutual good fellowship. Where possible it is a good plan to provide a program which can afterward be referred to by visitors, as in the case of some science classes one of the lessons or exercises afterward given the students is to report on the impressions made and the information gained by the visit.

JAMES VOSE.

Manchester, Eng.

A Slotter Tool Holder.

The illustration shows a slotter tool holder which I made over three years ago. It is the most satisfactory one I have ever used. For plain slotting, I use two screws on the side or bottom to hold the tool. For adjusting a flat tool I use two



A SLOTTER TOOL HOLDER.

screws on both sides. With these the tool may be adjusted so as to come flat on the work and a lot of grinding and trying is thus avoided. C. W.

Should a Machinist Sit While Working?

I have read with interest articles at page 675, Vol. 28, Part 2, and pages 91 and 122, Vol. 29, entitled "Should a Machinist Sit While Working?" Having myself done quite a lot of sitting I feel qualified to explain some of the reasons why a machinist should sit when possible. When one is walking around, or working a lathe or machine where he is required to change work constantly or for any reason keep on the move, the usual 10 hours on foot does not bother the average man, but give a man a standing job where all he does is to change the weight of his body from one foot to another, and 10 hours leaves him in no condition to enjoy his evening or spend it in study. He is too tired to do either. I suppose there are many old machinists who have become so used to this way of working that they will differ with me. I am a young man and have not had time to get used to such a condition and don't intend to if I can avoid it. I would

rather be a motorman on a street car pulling a hand brake all day, as far as physical exertion is concerned. The first time I sat down in working hours was against my will, in the apprenticeship days. A lot of gas-engine cylinders were being bored on an old 32-inch lathe. There was a gib on the back of the carriage but none on the front, so to get any kind of a hole, weights were piled all over that carriage until it looked like a junk heap with yours truly sitting on top, and there I had to stay through several dinner hours, as when a finishing cut was started nothing but an accident was allowed to stop it. I always make it a point to ask the foreman whether he objects to one sitting during a long cut and if by any chance he does (only one ever did and that was because he was afraid of losing his job) I would ask to be changed to different work or quit.

Canada. W. L. McLAREN.

Table for Dimensioning Dovetail Slides and Gibs.

This table was figured for machine-tool work, so as to enable one to tell at a glance the amount to be added or subtracted in dimensioning dovetail slides and their gibs, for the usual angles up to 60 degrees. The column for 45-degree dovetails is omitted, as *A* and *B* would of course be alike for this angle.

In the application of the table, assuming we have a base with even dimensions, as in the sketch Fig. 1, and we wish to obtain the dimensions *x* and *y* of the slide Fig. 2, allowing for the gib which we will assume to be ¼ inch thick, the perpendicular depth of the dovetail being ⅝ inch, and the angle 60 degrees, we look under column *A* for ⅝ inch and find opposite this that *B* is 0.360 inch, which subtracted from 2 inches gives 1.640 inches, the dimension *x*. To find *y* we first get the dimension 1.640 inches, then looking under the column for 60-degree gibs, find *D* (where *C* is ¼ inch) to be 0.289 inch, which is to be added obtain 1.929 inches.

In practice we usually make this dimension a little larger, say to the nearest 64th, to allow for fitting the gib.

H. F. N.

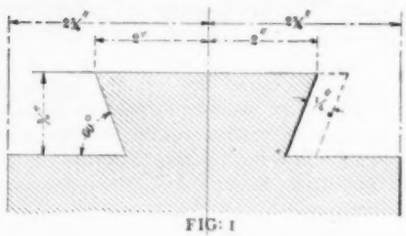


FIG. 1

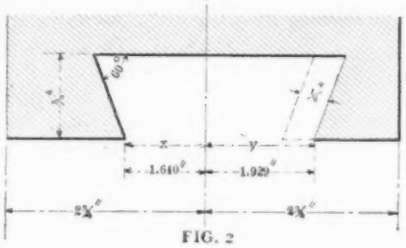


FIG. 2

DOVETAIL SLIDES AND GIBS.

A	B	B	B	C	D	D	D	D
1/32"	.018"	.022"	.027"	1/8"	.144"	.152"	.163"	.176"
1/16"	.036"	.044"	.053"	5/16"	.216"	.228"	.244"	.264"
1/8"	.072"	.087"	.105"	1/4"	.289"	.305"	.326"	.353"
1/4"	.144"	.175"	.210"	5/16"	.361"	.381"	.407"	.442"
3/8"	.216"	.262"	.314"	3/8"	.433"	.457"	.489"	.530"
1/2"	.288"	.350"	.420"	1/2"	.577"	.610"	.652"	.707"
5/8"	.360"	.437"	.525"	5/8"	.721"	.762"	.815"	.883"
3/4"	.433"	.525"	.629"	3/4"	.866"	.915"	.979"	1.060"
7/8"	.505"	.612"	.734"	7/8"	1.010"	1.067"	1.142"	1.237"
1"	.577"	.700"	.839"	1"	1.154"	1.220"	1.305"	1.414"
1 1/8"	.649"	.787"	.944"					
1 1/4"	.721"	.875"	1.049"					
1 3/8"	.794"	.962"	1.153"					
1 1/2"	.866"	1.050"	1.259"					
1 3/4"	1.010"	1.225"	1.469"					
2"	1.154"	1.400"	1.677"					
2 1/4"	1.298"	1.575"	1.888"					
2 1/2"	1.442"	1.750"	2.097"					
2 3/4"	1.588"	1.925"	2.307"					
3"	1.732"	2.100"	2.517"					
3 1/2"	2.020"	2.450"	2.935"					
4"	2.308"	2.800"	3.356"					
4 1/2"	2.598"	3.150"	3.776"					
5"	2.885"	3.501"	4.195"					

TABLE FOR DIMENSIONING DOVETAIL SLIDES AND GIBS.

Removing a Pinion From Its Shaft.

The article by Chas. A. Trask at page 119, reminds me of the way I took a pinion off the shaft of a logging locomotive once.. The pinion was of cast steel as tough as leather. It and its key were stuck fast. I got some blue clay, plastered it around the shaft close up to the hub. I then heated the pinion with a gasolene torch. When hot enough to boil water dropped on it, one blow with a sledge drove it off, key and all.

WM MACCORKELL.

Comparison of the Rust-Resisting Qualities of Steel and Iron.

I notice at page 264 an extract from the *Woodworker* giving an account of the rusting of cut and wire nails. After twenty years' exposure the first-named nails were practically as good as new and the wire nails were rusted through. The article also stated that galvanized nails would last even longer. This I think is an error, as I find galvanized goods are very imperfect and will rust just as quickly as common iron. The whole difference between the cut and wire nails is the material they are made of. I made an experiment some years ago to discover the keeping qualities of old-fashioned puddled iron, our present machine steel and English cast steel. I took three pieces of equal length of ¾-inch round metal, one being common puddled iron, one soft machinery steel and one English cast steel, and placed them in a corner of my blacksmith shop in a damp place, in such a position that they would not be disturbed by anyone. I did not even cover them up. As near as I can remember, they lay there almost a year. When I finally examined them I found to my surprise the English cast steel and the machine steel had only a little core of metal about 1/16 inch diameter left in the center, the balance being rust. The iron was only rusted a little and was almost the same size as when placed there. I don't think we have made any advance over the old-fashioned way of producing iron, as far as rust-resisting is concerned. While we have tensile strength in bessemer steel, the resistance to corrosion is lacking. I have also found that the bessemer process will not stand such hard usage as iron. I would be pleased to hear the expressions of others in this matter. HERMAN FLETCHER.

When the first two tons of anthracite coal were brought into Philadelphia, in 1803, the good people of that city, so the record states, "tried to burn the stuff; but, at length disgusted, they broke it up and made a walk of it." Fourteen years later Colonel George Shoemaker sold eight or ten wagonloads of it in the same city, but warrants were soon issued for his arrest for taking money under false pretences.—*The Engineer.*

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The World's Supply of Iron and Coal.

The enormous and rapidly increasing consumption of iron is leading to anxious inquiries regarding the available supply, and it will come as a surprise to most Americans to hear that, while our annual consumption is far in excess of that of any other country, we rank among the smaller countries in workable deposits.

Several months ago the Parliament of Sweden passed a resolution calling for a report showing the extent of the known deposits of iron ore in the leading iron-producing countries together with the rate at which such deposits are being consumed by the steadily expanding requirements. The report was made by the chief of the Swedish geological survey, and has been widely published with general acceptance of its substantial accuracy though with exceptions to some of its details. The general prediction based on this report is that with the present rate of consumption a single century will see the world face to face with an iron famine.

The estimate of the Swedish geological expert is that the total known workable deposits of iron ore aggregate 10,000,000,000 tons, while the present annual consumption is exactly one per cent. of this or 100,000,000 tons. The total workable deposits of iron-producing countries are as follows:

Country.	Workable deposits.
United States	1,100,000,000
Great Britain	1,600,000,000
Germany	2,200,000,000
Spain	500,000,000
Russia and Finland	1,500,000,000
France	1,500,000,000
Sweden	1,000,000,000
Austria-Hungary	1,200,000,000
Other countries	
Total	10,000,000,000

In annual output we lead all countries with 35,000,000 tons, Germany being second in the list with 21,000,000 tons, and Great Britain third with 14,000,000 tons. Our own consumption is, however, exactly equal to our output, while both Germany and Great Britain are large importers of iron, and their consumption is thus largely in excess of their production, the consumption of Germany being 24,000,000 tons, and of Great Britain 20,000,000 tons per annum. Simple division shows that at the present rate our own deposits will be exhausted in a little more than thirty years, and of course no one expects the present rate of consumption to continue, a large increase being inevitable.

For coal the figures reverse themselves for, while the coal supply of the leading European nations is giving rise to much apprehension, our own is secure for centuries to come. The exhaustion of the English coal measures is predicted in from 60 to 100 years, while in France the supply is expected to be exhausted in a generation or more. Germany is better off, but the subject there has become so acute that the Government objects to the export of coal, a recent heavy contract for the sale of German coal to France having been canceled because of the Government's objections.

It would appear that the effect of the known limits to the supply has already made itself felt on the prices of coal in France which, judged by our own standards, are very high. The wholesale prices of coal delivered at the gates of Paris, not including the octroi duty, are at present $10.03 for bituminous lump and $11.98 for anthracite per metric ton.

These facts would seem to indicate that the not distant future may see an active trade between this country and Europe in coal and iron, this country exporting coal and importing iron.

In this connection we cannot, however, fail to recall the dismal prophecies of the geologists of twenty years ago regarding the production of gold. They were quite sure that the deposits of that metal were all known, and their prophecies of a short supply of gold were quite as confident as their present prophecies of a near-by shortage of iron. The world knows today that they were very happily mistaken in one case, and it is quite possible that they may be in the other.

The James Watt Memorial.

We learn from the London *Engineer* that the fund for the erection of a memorial at Greenock to the memory of James Watt has now reached the sum of 10,200 pounds sterling, all but about 900 pounds of which were subscribed by Andrew Carnegie. It has been decided that the memorial shall take the form of a commemorative public building and statue to be erected on the site of Watt's birthplace. The estimated cost of the proposed building is 6500 pounds, leaving a fair balance for endowment and other necessary expenses.

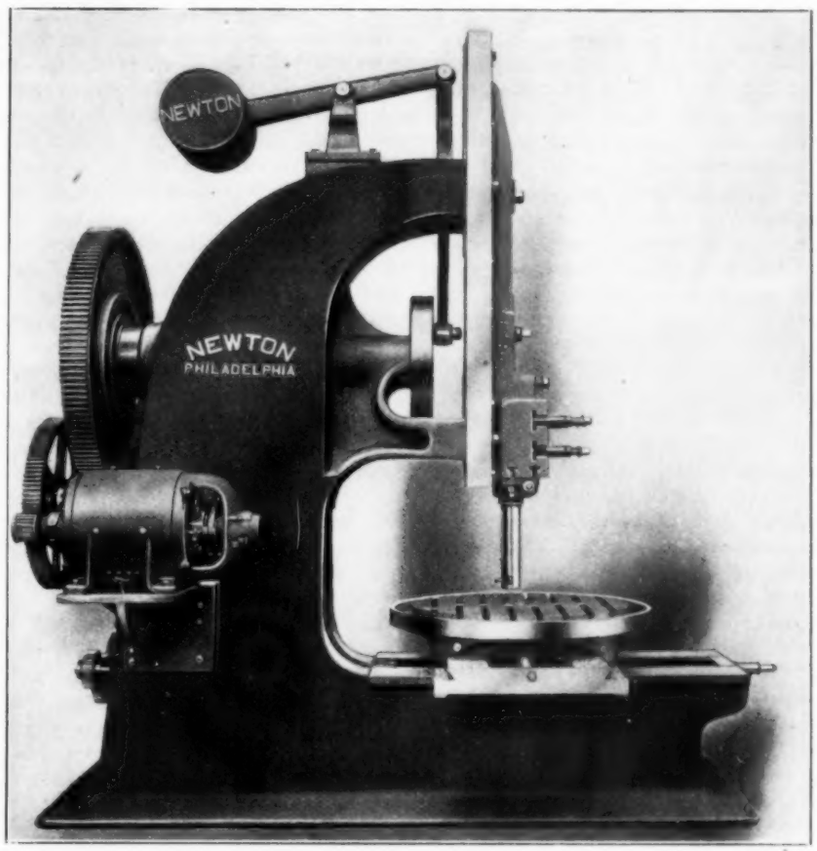
It is a somewhat mournful reflection that after a very thorough canvass the sum raised to commemorate the work of the man who is in a very large sense the father of modern civilization should be no larger than it is. The effort to raise more money seems, however, to have been abandoned, and in view of the limited results which have followed the efforts that have been made, it is impossible to conclude otherwise than that this decision is wise.

Compressed paper pulp, impregnated with certain salts, is molded into the form of saucepans, which, on account of their lightness, were used largely by the Japanese army in Manchuria. They stand the fire well, provided they be kept full of liquid. They have been adopted by the German army, and have been introduced into Antwerp.—*The Engineer.*

New Tools and Machine Shop Appliances.

20-INCH SLOTTER.

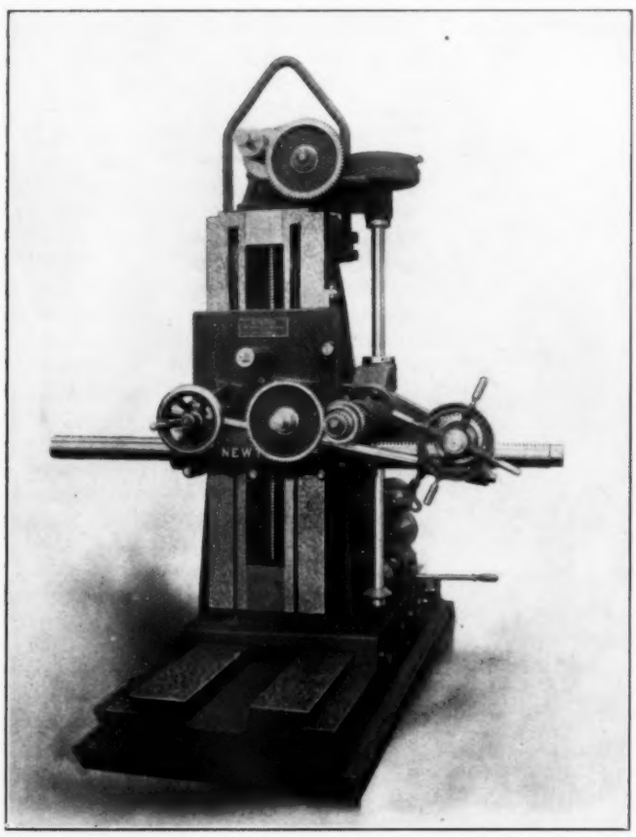
In the 20-in. stroke slotting machine, shown by the half-tone, the ram has a full stroke of 20½ in. and is adjustable for any position in the length of stroke up to its capacity; it is counterweighted and has a quick return movement, and is driven by a 7½-h.p. variable speed motor mounted on a bracket on the side of upright. The main driving gear is 48½ in. diameter by 4½-in. face with a ratio of gearing of 11½ to 1, and a further reduction in ratio of gearing to the motor. The ram is fitted in an adjustable guide with an angular bearing and the half English shoe type of gib. The ram as shown is also fitted with a slotting bar, which has a hand-rotary movement for use in working out fillets on locomotive work, the slotting bar being 3½ in. in diameter, with an extension which fits into a hole bored in the ram. The circular carriage is 38 in. over tee slots, and 46¼ in. over all, has an in-and-out feed of 33⅞ in. and a cross-feed of 28 in., will admit work under frame 26 in. high and has a distance from face of ram to frame of 37½ in. Circular carriage has variable automatic quick-acting feed in all directions arranged so as to be controlled from one point. This machine, which weighs about 20,000 pounds, is built by the Newton Machine Tool Works, Philadelphia, Penn.



20-INCH SLOTTER.

PORTABLE BORING, DRILLING AND MILLING MACHINE.

We publish herewith two views illustrating a small portable boring, drilling and milling machine. The spindle of the machine is 3½ inches in diameter and is



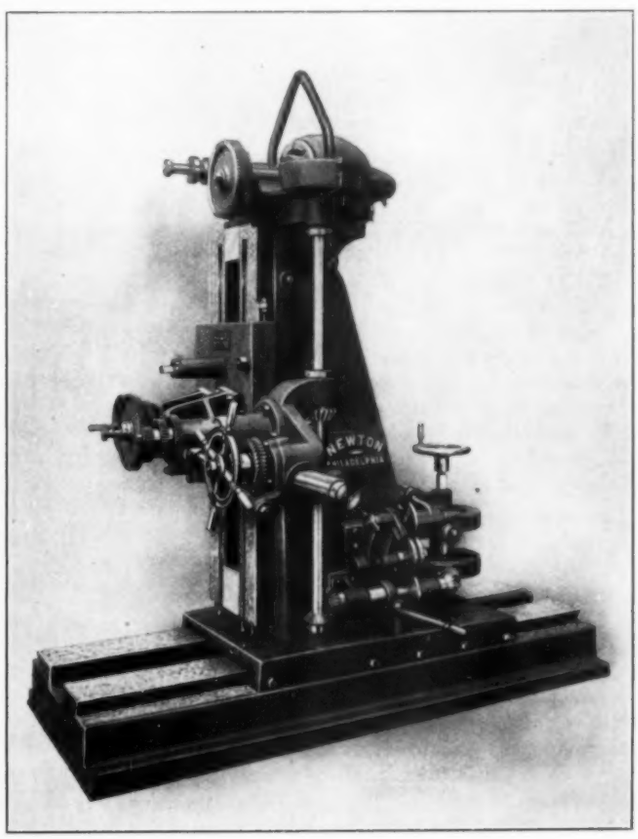
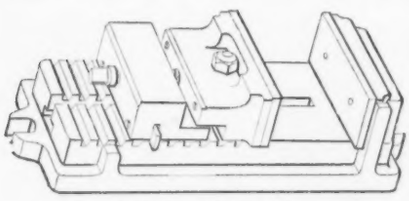


FIG. 1. PORTABLE BORING, DRILLING AND MILLING MACHINE. FIG. 2.

driven by means of a phosphor bronze worm wheel and hardened steel worm (which runs in oil) through gearing by a 3-h.p. motor, mounted on top of upright. The motor has a variation of speed of 3 to 1, which, with the slip gears shown on top of machine, gives a variation of speed to the spindle of 6 to 1. The spindle has 24 inches of automatic feed with three changes through gearing with hand slow and quick movement. The spindle saddle is counterweighted, counterweights running inside of uprights, and has 36-inch adjustment of the column. The column has 40-inch automatic feed, and power quick return on the base for milling, the feed being variable through friction disks; the length of the base, of course, can be extended to give any length of horizontal adjustment required. The hand wheel shown on the back of upright controls the feed and quick power movement to the upright; by turning the hand wheel in one direction the clutch is engaged with the upper worm and worm wheel for the feed; reversing the direction, the clutch is engaged in the lower worm and worm wheel for the quick power movement. The bottom and edges of base are finished parallel and square to the travel of the machine, for convenience in setting to the work. The same machine is also made as a floor-boring machine. The Newton Machine Tool Works, Philadelphia, Penn., is the builder.

A DRILL-PRESS VISE.

The illustration shows a vise which can be used on the drill press, planer, shaper, etc. The quick adjustment of the moveable jaw to approximate position is by means of a flat steel key which engages



A DRILL-PRESS VISE.

with a slot in the rear part of the jaw and with slots in the base. The final tightening of the jaw is by a screw. The movable jaw is so constructed that it will swivel to hold tapered work. This vise is made by The Skinner Chuck Company, New Britain, Conn.

One method of making a muffler for a gas engine is to split the end of the exhaust pipe for about one foot and spread the split ends; another is to drill a number of holes or saw several slots across the last few feet of the pipe.

Some locomotive cylinder castings on the New York Central & Hudson River Railroad are being made of cast steel, with gray-iron bushings for the pistons and piston valves to work in.

Power Required to Thread, Twist and Split Wrought Iron and Mild Steel Pipe.*

Some time ago my attention was called by the National Tube Company to steps that it is taking along the line of inducing manufacturers of dies to make certain improvements in the form of the dies that will enable the fitters to cut better threads with a smaller expenditure of energy than obtains at present with the ordinary forms of dies. I have investigated the matter a little from an educational standpoint on behalf of the International Correspondence Schools, of Scranton, with a view to imparting reliable instruction to our students, many of whom are located in out of the way places, and even in foreign lands.

There are two kinds of steel pipe and two kinds of wrought-iron pipe on the market—namely, good wrought iron and poor wrought iron, good steel and poor steel—and you cannot ordinarily distinguish between them till after the goods are bought and the men are cutting and threading them on the job. Some will split, some will chip as if made of crystal, in some the threads will strip, while others may even break across like glass bars. At the same time the trade must have very good uniform dies, and very good uniform pipe. If they cannot both be obtained at once, then let us get one at a time.

The plumbing and heating trades experience a great deal of trouble with pipe; the seams frequently become split while the pipes are being threaded, and considerable loss of time and money is occasioned all around. The reason why the seams become split is because they are not as strong as the rest of the pipe. If they were as strong as the pipe, then it would either twist or tear when an excessive force tends to open the seams.

Most of the splits in the trade are produced, I believe, in threading butt-welded pipes. The lap-welded pipes evidently do not split so frequently. The teeth of the dies in cutting the thread at the butt-weld seem to catch squarely against the weld. The cutting face of the die is radial, that is, it points toward the center of the pipe. The cutting edge, therefore, is a right angle. This kind of die, I understand, is today used more or less by nearly every firm in the heating business. I call this an imperfect design, because it does not have an acute-angle cutting edge like any other cutting tool.

All tool manufacturers know that there is a certain angle or rake that is best adapted for cutting different metals in the most easy and most perfect manner, but it seems that the die makers are very slow in methodically introducing this principle into the die business.

*Abstract of paper read by T. N. Thomson before the American Society of Heating and Ventilating Engineers, New York, January 18.

A large number of experiments on different forms of dies, the cutting rake, etc., go to show that the best angle of rake for dies that are to be used only on wrought-iron pipes is about 12 degrees; the best angle of rake for dies to thread only mild-steel pipes is about 20 degrees, and the best angle for a die that is suitable for both wrought-iron and mild-steel pipes is about 17 degrees, and it can be greatly improved by having the die cut with a relief so that the die will bear on the pipe only at the cutting edge.

The power was measured for threading both wrought-iron and mild-steel pipe with both the square-edge die and the improved die. [The pipe was held in a lathe-clutch and steady rest, a die run on the projecting end and a spring balance connected to the arm of the stock]. A test made on this machine with two samples of good pipe gave the results shown in Table 1. The dies were both in good condition.

Kind of pipe.	Old form of die. Pull in lbs. on a 21-inch lever.	New form of die. Pull in lbs. on a 21-inch lever.
1¼-in. wrought iron.	83 to 87 lbs. pull.	58 to 62 pounds.
1¼-in. mild st'l.	100 to 111 lbs. pull	60 to 65 pounds.

TABLE 1.—TESTS OF DIES.

The samples used in the above test were ordinarily good quality pipe picked out at random. It shows that the power required to thread mild-steel pipe with the new die is not much more than that required to thread wrought-iron pipe with the same die, and much less than the power required to thread wrought-iron pipe with the common die.

This is an improvement in dies that makes the threading operation very easy on the men. If men are expected to do good work and keep it up, all needless expenditure of energy should be eliminated. I do not see the use of a fitter pulling 100 pounds on a stock arm if a pull of 60 pounds can be made to accomplish the same purpose. An objection may be raised to the effect that if a pipe is so poor that it will split while being threaded it has no right to be installed as part of a heating or power system. The objection is strictly correct, but it is no reason why we should depend on testing pipes for splitting proclivities by cutting threads on them.

The tests of the National Tube Company, I am satisfied, are very thorough, and are exceedingly valuable records, but as they were all made on machines, and as ½, ¾ and 1-inch pipes are threaded by hand in pipe vises, I made a number of tests at the laboratory of the International Correspondence Schools with a view of obtaining as nearly as possible the strains that are actually placed on pipes in practice. We secured a number of samples from different supply houses and from the pipe racks in the plumbers' and fitters' shops in Scranton, the idea being to test the regular nondescript merchant pipe

in common use and find out how much power is actually required to thread and split this class of pipe by the mechanics on the jobs. To make the threads we borrowed the tools from the trade, so that there also we would get actual practical results. In making the tests we used a pipe vise and Stillson wrenches, so that the action of their teeth and the shifting of grips would all form a part of the tests. Of course it must be expected that tests made this way will develop entirely different results from tests made in machines with properly designed clamps and a steady application of the power. While the International Correspondence Schools tests give an idea of what takes place at the pipe vise with hand tools, the National Tube Company tests show what may be expected at the threading machine.

We rigged up the apparatus with two rigid 2x8-inch uprights; each have three holes bored through, one being for 1-inch pipe, one for ¾-inch pipe and the other for ½-inch pipe. The pipe in all cases was grasped by a vise which was bolted to the center of a 4x4-inch timber. The pipe was lubricated where it passed through the uprights. As the arms of the stocks were 18 inches long from the center of the die to the extreme end, and as the actual distance of the center of a man's hand will be about 2 inches from the end of the stock arm, we attached an eye-bolt to the 4x4-inch timber so that the hook of the spring balance would be 16 inches from the center of the pipe in the vise. In this way we can read on the spring balance the amount of pull a fitter has to apply to the dies. For convenience the power required to twist and split is also given with the balance at a 16-inch lever.

Kind of pipe.	To thread; well oiled; steady pull at 16-inch leverage on die stock arm.			To twist. Steady pull with Stillson's.	To split. Steady pull with Stillson's.	Margin of safety.
	New rake dies.	New common dies.	Old common dies.			
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
¼-inch steel. (4 samples)	34.5	56.25	60.5	122.5	152.5	73.85
¼-inch iron. (7 samples)	27.14	33.14	49.14	102.14	110	46.12
¾-inch steel. (4 samples)	44.25	60.5	90.75	150	240	122.05
¾-inch iron. (8 samples)	44.375	51.25	73.5	140	176.43	80.88
1-inch steel. (5 samples)	68.8	111	124	286	420	258.8
1-inch iron. (7 samples)	62.14	105.7	118.57	272.85	326.66	172.52

TABLE 2.—APPROXIMATE POWER REQUIRED (POUNDS) TO THREAD, TWIST AND SPLIT PIPE.—SUMMARY.

The difference between the threading operation and the twisting operation is that in the latter the dies were removed. Stillson wrenches were applied to the other end of the pipe, where it passes through the upright and the pipe was twisted by these wrenches. Of course the wrenches chewed into the pipe, and so did the vise, but this is a true condition of the trade and it is well for us to know what happens under such conditions. The records were all taken during steady pulling. When the dies were pulled quickly in jerks or run dry, the power increased anywhere from 30 to 50 per cent. The old common form of dies referred to was in very fair condition, the 1-inch die being particularly good. It did not cut down to gage, and its record consequently is rather low. A summary of the results of the tests is given in Table 2.

In making the torsion tests, we had to screw up the vise tightly to prevent the pipe turning and this tended to crush the pipes and start the seam. Most of the splits started at the vise. Galvanized pipes were more difficult to hold than black pipes.

The margin of safety column at the right-hand side of Table 2 is compiled by adding 30 per cent. to the power required to thread with old dies and subtracting the sum from the power required to split the pipe. If the mechanic pulls on the dies beyond that limit, due to dull and imperfect dies, or due to a hard spot in the pipe, he certainly will, according to the nature of things, split the pipe. Or, if the power required to split is nearly the same as the power required to thread, as in the case in the last sample of ¾-inch pipe in the mild steel list (which, on test, proved to be ⅜-inch galvanized iron), then the pipe will certainly split through no fault of the mechanic, but through defective tools combined with a quick, jerky motion which the men must put on the dies if they are going to hustle along the work. With dies having the proper rake there would be no danger of splitting this pipe while threading it.

It is noticeable that the margin of safety for the steel pipe is much greater than for the wrought-iron pipe, and it seems rational to assume that the trade must experience trouble by wrought-iron pipe splitting at the vise as well as steel pipe. Judging by the tests, it is evident that common steel merchant pipe will ordinarily twist before it splits and that common wrought-iron merchant pipe will sometimes do the same thing; but the iron will not twist as much as the steel and requires on an average less power both to split and twist. However, in wrought iron, this weakness is somewhat compensated for by the smaller amount of power required to thread.

My opinion of the entire case, independent of all outside influences, is that correctly made dies are a step in the right direction, and that die makers should make all their dies with a rake that is best adapted for threading both wrought-iron and mild-steel pipes, and with sufficient relief to reduce friction. I would suggest for your consideration the preparation of a standard torsional test that any intelligent mechanic can easily and quickly apply on a job to any length of butt-welded pipe, with the object of determining whether or not the weld is sufficiently strong to warrant its use in a building.

National Machine Tool Builders' Association.

We have received a letter from E. M. Woodward, president of the National Machine Tool Builders' Association, in which he says:

"The National Machine Tool Builders' Association will hold its convention at Atlantic City at the Chalfonte Hotel, May 1 and 2. There is a manifest feeling that our spring convention should be strictly for business, at which builders of all the various types of machine tools that our association represents, will be given ample time and opportunity for getting the committees together under their respective heads to discuss such matters as are pertinent to their particular branch. In order that this may be fully accomplished, it is probable that the first day will be devoted to this kind of work. A program of the business of the convention will be issued later."

The college of engineering of the University of Wisconsin has just received a Curtiss steam turbine, which is being installed in the mechanical laboratory of the engineering building. The new machine, which is in part the gift of the General Electric Company, will be used for the instruction of students and for experimental work. It is of 35 horse-power capacity. Owing to the increasing importance of this kind of machine in electrical plants, as well as its successful application recently for ship propulsion, the college of engineering considers itself very fortunate in securing this valuable addition to its laboratory equipment.

In the Official Gazette of the United States Patent Office, of February 6, 1906, there is a notice of assignment from the Pennsylvania Railroad Company, dedicating to the public the invention secured by patent No. 790,690, of May 23, 1905, to Wm. S. Kiesel, for improvements in tank cars, which relates to a steel construction including a body bolster, so made as to serve as a saddle for the tank. This is a species of donation which we do not see every day.

Echoes from the Oil Country — Some of the Old Ways.

BY W. OSBORNE.

"We are short-handed this morning. I am afraid that I will not be able to get out the work quite as I said I would. What had I better give the preference if I find that I am falling behind?" It was Monday morning, and one of the foremen had dropped in to see the superintendent.

"What is the matter that the men are not all in?"

"Frank sent in word that he has a very sick child that he has been up all night with. Tom was nearly knocked out last week and I suppose he is clear down again, and I more than half believe that Bob has gone to work for the cider-press company. He didn't say anything about it to me; but when he did not show up I asked Jim (Jim lives up near him, you know) if he knew why he wasn't in, and Jim said he was, for he had seen him go by with his dinner pail. But he isn't here."

"I suppose he will try it there for a few days, and if he doesn't like it, he will come back with a great tale about how sick he has been and be very indignant if he finds that we do not want him. Stop at the house on your way home tonight and find out the truth of the matter, and if he is trying to work us, put on another man in his place."

There is nothing new in this.

"Good morning, sir. What are the chances for a job?"

"We have all the men we need at present."

"I am a good, steady man. I don't drink or carouse around, and you will always find me at work when the whistle blows. I learned my trade in a good shop, and learned it right, and can give you some first-class references." And the man hands out a number of letters which are glanced over.

"If you could stay around a week or two I might be able to put you on." A lot of things can happen in a week.

"I understand that you are needing men and if I would suit you at all, why can't you put me on at once? I can hardly afford to hang around and not know whether I will get work or not."

"I don't need any men at present."

"How does this come, then?" And the man pulls a paper out of his pocket and points to an advertisement for men. It says that steady work will be furnished to steady workmen, and bears date of yesterday.

"That is an old advertisement that we put in several months ago, and they have made a mistake and not taken it out, as they should have done; but we do not need any men today. You might come around in a day or so."

The man passes out, and evidently the firm is too busy to give any further thought to the small matter of stopping their advertisement for men, for it comes out again in the next Sunday paper.

There is nothing new in this.

"Say, Bill, I am going to quit and go down to Pittsburg and hunt for a job. You had better come along."

"All right. I'll do it. I don't like the foreman, anyhow, and I'll just tell some of the boys that I have a letter from my old boss offering me fifteen cents more an hour than they pay here; then I'll brace him for a raise, and he will tell me how sorry he is that he can't do it, and all about the droves of men that are nearly mobbing him to get in, and then we will part good friends, and if I ever have to come to this hole of a place again I may be able to get a job. What will you tell him?"

"I'll tell him that my brother has been hurt, and that I will have to go and look after him. He will get my money for me, and perhaps hold the job open. If we don't strike anything that suits, my brother can get well enough to leave."

"Maybe Bunnie would quit, too, if we told him we were going."

"Don't say a word to him. He is the worst kicker in the shop, but you couldn't drive him away with a club. The big trouble with him is that he kicks when there isn't anything to kick about. That kind make a foreman case-hardened, so he don't listen to a kick when he ought to. If I was the foreman I would tell him to either look for another job or else quit kicking, and you would see the meekest little man in the place. He's worse than the foreman is, I do believe."

There is nothing new in this.

"I have a couple of men that I don't know what to do with. They seem willing enough, and go at anything they are told to do, but they don't seem to accomplish anything. I've tried them everywhere I dared to. What had I better do with them?"

It was one of those conditions of a misfit and the superintendent was soft-hearted, or perhaps he simply wanted to do things the easiest way for himself. "Lay them off, and tell them that work is a little slack, and that they had better look for a job somewhere else. Let them understand that there is no use of waiting around to be put on again. That will let them out without hurting their feelings. They have been here quite a while, and are both hard workers, and it is rather rough to tell them that you think they are no good. If they were new men it would not matter. I will give them letters that may help them get jobs."

This last statement helped the foreman in his interviews with the men. "Work has quieted up a bit, and we will have to begin dropping some of the force. You have been here quite a while, and so I came to you first, so that you could have the first chance to look for another job before the others. The superintendent will give you a letter of recommendation, and I will see that your money is ready for you. No, I don't think that there is any use of hanging around waiting for things to pick up again. It is the wrong time of year. Better hustle for something else right away, and her's hoping that you get it."

The letters that the superintendent, in his pity, wrote were so good that the men were glad they had been laid off, or would have been if work had not soon got poor in the new place; but they added to their stock of nice letters by the move, if not to their stock of mechanical ability.

There is nothing new in this.

"I am afraid that you will not suit for the job I need a man on."

"I have had lots of experience. I served my time and then worked for B——, and S——, and A——, and R——, and—"

"Did you ever work in an engine shop?"

"Sure thing I did. I worked in steam-engine shops and gas-engine shops and hot-air engine shops and—"

"I suppose you have had some experience on fine work. Did you ever work in a shop making machine tools of any kind?"

"Oh, yes. I certainly did. I've worked in lathe shops and planer shops, and where they made drill presses, and punches and presses, and all such stuff as that."

"You seem to be a man of considerable experience. You must have worked in a number of cities."

"Yes. Hartford, Providence, Jersey City, Buffalo, Bradford, Pittsburg, McKees Rocks, Denver, Atlanta, Sharon, Cincinnati and some small places that you would not be likely to know in this part of the country."

"You gave satisfaction in the places where you have worked, I suppose?"

"I never worked in a place where I couldn't go back again and work. I have had lots of letters from foremen who wanted me to come back."

"You are looking for steady work and would hold on to a job if you got one, would you?"

"That is just what I am looking for. I want a steady job. I am a great man to work steady. I always like to help a foreman out and give the shop a lift. If you want a man that you can always depend on, I will suit you. I can get letters from a dozen foremen, who will tell you the same thing. I got kind of out of the way of getting letters. Some shops don't seem to care for them, especially in the little places. If I could prove everything as easy as that I am steady I could prove anything."

This man did not look to be past middle age, but the foreman knew that appearances are deceiving oftentimes. Putting together the fact of his steadiness along with the number of places where he had worked and the number of people he had worked for, it was very clear that he was nearing the century line. A man of that age is rather old to begin to learn the

ways of a new shop, even he is a steady man and young looking. The foreman had known of a man who, by his own tell (the boys had been interested in following his career and had kept tab on the places where he worked, and the length of time) had spent something like 243 years in the shops; but in some way he had become prejudiced against these "old fellows."

"You may leave your name and address, and if I need you I will send for you."

There is nothing new in this.

Some people never read between the lines and some people read altogether too much there.

Legal Notes.

BY E. P. BUFFET.

WHERE EMPLOYER IS RESPONSIBLE FOR DETAILING OF MEN FOR A JOB.

The evidence tended to prove the following facts: H. was employed as a helper in the machine shop of the N. Mfg. Co. and was without experience in repairing shafting. One day a line of shafting in the boiler house broke about four feet from one end. The line was about 40 feet long and suspended about six feet above the boilers by J hangers. The company's master mechanic, who had charge of all the machinery and the men employed to repair it, directed a machinist K. to take H. as a helper and repair the break after the mill had shut down. In order to do so it was necessary to separate the broken ends of the shafting and join them with a coupling. K. and H. were unable to push the long piece through the boxes because it was worn and gummed. They cleaned the shafting, and, being still unable to move it, they removed the caps from the boxes. Then they separated the broken ends, screwed a coupling to the short piece, pushed the long piece back and inserted its end in the coupling. By K.'s direction H. proceeded to screw the long piece into the coupling with pipe tongs while K. held a light. At about the third turn the shafting rolled out of the boxes and fell on H., injuring him. If the caps had been replaced after the end of the long piece was inserted in the coupling, or had they merely been loosened, the accident could not have occurred. They were not replaced because K. thought the shafting could safely be turned without them. The shafting fell because it was out of line, or because there was some trouble with the box in the hanger farthest from the point where the men were at work. Apparently someone should have been around to watch the shafting while the others worked upon it, or enough men employed to push it through the boxes without removing the caps; and if either of these precautions had been taken the accident could not have happened.

H. has recovered damages against the company and has been sustained by the Supreme Court of New Hampshire. The case hinged partly upon whether in detailing an insufficient number of men for the job the master mechanic acted as a vice-principal, so as to bind the company, or whether his act was that of a fellow-employee, and the company, having employed an adequate number of men to do the work in safety, was irresponsible for the fact that they were not used here. In holding the company liable the case is distinguished from some others in which an employer has been held unaccountable for the selection made of the facilities furnished by him. The fact that the injured man did not have additional help within his own control is one of the circumstances here considered.

62 Atl. Rep., 592.

WARRANTY ON FURNACE APPLIANCES.

A New York machinery and supply house installed for a Providence manufacturer an outfit of grates and blowers. The letter offering the equipment, which was replied to with an acceptance, contained the following clause: "The ——— system is adapted to the burning of fine anthracite fuel." The buyer tried the appliances and took them out on the ground that, using fine anthracite coal, the boilers did not produce enough steam for the plant, into the justice of which claim we need not enter. The seller sued the purchaser and lost, but on appeal to the Supreme Court of Rhode Island he has been granted a new trial. The appeal court holds that by uncontradicted evidence the system was adapted to burning fine anthracite fuel, and that the words quoted did not constitute a warranty that this equipment would produce steam enough for the particular plant. And although evidence was offered to show that the buyer had declared himself unwilling to put in the new equipment unless assured of results similar to those heretofore attained at the plant, the court holds that there was no implied warranty that this would be accomplished, because it is the rule that where a known, described and defined article is ordered, although it is stated to be required by the purchaser for a particular purpose, still if the known, defined and described thing be actually supplied, there is no implied warranty that it will answer the particular purpose intended by the purchaser. The buyer had in this case further sought to rely on a clause in the letter above quoted from, that "There will be no delay in the operation of your plant." This, however, the appeal court construes from the context as applying only to delay by the work of installation, although the court below had tried to extend its meaning to embrace the performance of the furnace.

62 Atl. Rep. 373.

RIGHTS OF AN INVENTOR UNDER AN AGREEMENT.

A case in New Jersey Chancery pertains to the relations of a wire company with its former president, who had sold out his stock to it with an agreement limiting his right to enter into competition, but providing for the joint exploitation of inventions he might make along the lines of the company's work. The company asserts that subsequently he has offered them for this purpose a resistance material composed of copper, nickel and manganese, in proportions unknown, which he claims gives a resistance of about 425 ohms per mil foot, or about 40 times that of copper, and which will not rust and has a higher resistance than any metal on the market which will not rust. The question at issue seems to be partly whether the inventor is bound to disclose to the company the quantitative composition of this alloy, or whether he can leave that concern to ascertain the novelty by testing the performance—or possibly by analysis—and furnish the material as a "raw product" to be made up into a finished product by the company. The decision of the Vice-Chancellor at the stage of the case thus far reached, which may or may not be final, favors the company, this position being based on certain terms of the agreement and aspects of the case.

62 Atl. Rep., 461.

The Allis-Chalmers Club, of Milwaukee, Wis., has issued a brochure containing its constitution and by-laws. This organization was established for the office men, superintendents and foremen of the Allis-Chalmers Company to contribute to their comfort, social intercourse and efficiency, and is located in a former mansion house near the works. It has all the usual appointments of a club of this nature; dinner and supper are served to the members at approximate cost price, and the club is open in the evening for the entertainment of the members.

Personal.

John C. Bowers, who was for fourteen years superintendent for the Metal Stamping Co., of New York, has resigned his position to become vice-president and general manager of the "Bowers Metal Stamping Company," also of New York.

Emil Kessler, who for seventeen years has been connected with the E. W. Bliss Company, of Brooklyn, New York, in various capacities, has resigned his position to take charge at the die department of Zeh & Hahnemann, Newark, N.J.

Arthur Giesler has established himself as a consulting engineer at 170 Broadway, New York City, and will devote himself especially to hydro-turbine power plants and hydro-turbine pumping stations. Mr. Giesler, who has been intimately connected with water-wheel design and installation all his life, was formerly chief engineer and designer of hydraulic installations for the Platt Iron Works Company, of Dayton, Ohio, and is the inventor of the Giesler governor for water-wheels.

Obituary.

Edmund Bury, president of the Bury Compressor Company, Erie, Penn., and Albert J. Voettner, the shop superintendent, were killed March 2 by the bursting of a casting which was being tested under pressure at the works. Charles Warner, secretary and treasurer of the company and several workmen who were standing near by at the time of the accident miraculously escaped injury.

Mr. Bury was born at Over Darwen, near Blackburn, England, thirty-eight years ago, came to this country when a boy, and early in life started work as an apprentice at the shops of the Whipple Manufacturing Company at Cleveland, O. This plant later burned down, and he completed his apprenticeship in the Erie shops. He devoted his evenings to studying drafting and mechanics, and after becoming a journeyman worked as a toolmaker, designer, and in executive positions with various tool-building and engineering concerns, among these being the Pratt & Whitney Company, Hartford, Conn.; Frazer & Chalmers, Chicago; the Ingersoll-Sergeant Drill Company, Easton, Penn. He acquired a broad experience in matters pertaining to the shop and drawing office, and developed into a mechanic of marked ability, becoming in turn a skillful toolmaker, an able designer and a practical and conscientious director of shop operations. For four years prior to starting in business he was at the head of the tool and hardening departments of the Ingersoll-Sergeant (now the Ingersoll-Rand) shops at Easton, and in that capacity devised many special machines and appliances for the economical production of rock drill and compressor parts. In 1901 he formed a partnership with James Herron, of Erie, and a plant was erected by the firm at that place for the manufacture of air compressors. Mr. Herron retired from active partnership in the concern about a year ago.

Mr. Bury was a progressive business man, and at the time of his death had built up an important industry in Erie. He was a man of the highest character, and was universally esteemed by his associates. He had been a member of the A. S. M. E. since 1901. A widow and a son, the latter two years of age, survive him.

Mr. Voettner was born in Fairview, Penn., and had been employed by the company almost since its inception four years ago. He entered the shop a thorough mechanic, and was soon appointed superintendent. He was 33 years of age, and leaves a wife and two children.

Business Items.

The Dayton Pneumatic Tool Company has opened branch offices at 707 and 708 Lincoln Trust Building, St. Louis, Mo., with J. A. Prescott, southwestern manager in charge.

The Frevert Machinery Company have opened a salesroom and offices at 18 Dey street, New York, N. Y., where they carry a complete line of new and second hand metal working tools and machines of epery description. They are also manufacturing a line of newly designed hand power traveling cranes, trolleys, hoists, and overhead tracks.

There has been some confusion and delay in the transmission of mail matter and orders intended for The C. H. Wheeler Pump Company, owing to some similarity between its corporate title, and that of another concern. In order to avoid a recurrence of such confusion and delay, it was decided to change the corporate name to C. H. Wheeler Manufacturing Company, this change taking effect March first.

The "Quincy, Manchester, Sargent Company" has been incorporated and will take over the business heretofore operated by the Railway Appliances Company. This includes the business and plant of the Railway Appliances Company at Chicago Heights, Ill., formerly owned by the Q and C Company, also the business and plant of Pedrick & Ayer Company, of Plainfield, N. J., manufacturers of locomotive repair tools, electric and pneumatic hoists and cranes and pneumatic riveters. They will also act as sole selling agent for the product of the Elastic Nut and Bolt Company, of Milwaukee, Wis., and will maintain offices at Old Colony Building, Chicago, and 114 Liberty street, New York.

The capital of the Standard Roller Bearing Co., Philadelphia, Pa., has been increased from $2,000,000 to $3,500,000. This increase in their capital has been required to provide for an enlargement in their factory and equipment. A four-story factory 150x200 feet will be erected immediately for the manufacture of annular ball bearings, on which this company holds basic patents. During the past year, the Standard Roller Bearing Company have equipped with machinery, a four story building 95x200 feet, and have also built and equipped an iron foundry 70x150 feet, two stories in height; hardening and tempering building 70x150 feet, and a crucible steel castings plant 60x100 feet. With the new building which will be erected immediately, the company will employ over 100 hands, in the manufacture of steel balls, ball bearings, roller bearings and automobile axles and annular ball bearings.

Manufacturers.

The Rochdale (Mass.) Woolen Company, will erect a new factory.

Pratt & Letchworth, Buffalo, N. Y., have filed plans for a new foundry.

The Prentice (Wis.) Tanning Company's plant was burned. Loss $150,000.

The plant of the Gould Coupler Company, Depew, N. Y., will be enlarged.

The Eaton-Hurlbut Paper Company, Pittsfield, Mass. will build two additions.

The Youngstown (Ohio) Car Manufacturing Company is erecting an addition.

The Hammond Iron Works, Warren, Pa., may double the capacity of its plant.

The Holman Automobile Company, Chicago, Ill., will construct a $20,000 building.

The Lexington (Va.) Light and Power Company, will improve and double its plant.

The Lackawanna Light Company, Scranton, Pa., has purchased site for a new plant.

The Richmond (Va.) Foundry and Manufacturing Company will build a new plant.

The Thompson-Weitzel Leather Company, Chester, Pa., will make additions to its plant.

The Washington Power Company, Spokane, Wash., will increase the capacity of its plant.

A new foundry is being built for the Federal Railway Signal Company, Troy, N. Y.

The Columbus (Ind.) Handle Company, will erect new factory buildings at Madison.

The Warren City (Ohio) Tank and Boiler Company, is erecting a new engine and boiler room.

The Louisville (Ky.) Pottery Company, recently incorporated, has secured site for a plant.

The Haskell & Barker Car Company, Michigan City, Ind., will build an addition to its plant.

The Woodruff Hardware and Manufacturing Company, Winder, Ga., will erect a new foundry.

The Christy Knife Company, Fremont, Ohio, is figuring on an enlargement of its plant.

Gohmann Bros. & Kahler, stove manufacturers, New Albany, Ind., will erect a new foundry.

The Beaton & Bradley Company, plumbers' supplies, New Britain, Conn., will enlarge its plant.

The Pequannock Valley Paper Company, Butler, Pa., will spend $20,000 in enlarging its plant.

A new factory is being built for Bealer & Schmid, ornamental works, Washington, D. C.

The J. B. Clark Company, Minneapolis, Minn., will erect an $18,000 addition to its box factory.

The Great Northwestern Railroad is to build extensive additions to its shops in St. Cloud, Minn.

The Springfield (Mass.) Street R. R. Company is having plans prepared for a $40,000 repair shop.

The citizens of Muskegan Heights, Mich., have voted in favor of a municipal water works plant.

The Manhattan Rubber Company will make extensive additions to its plant at Passaic, N. J.

Fire destroyed the plant of the Hydro Carbon Manufacturing Company, Denver, Colo. Loss, $20,000.

The Geometric Tool Company, Westville, Conn., is having plans prepared for a new factory building.

The H. B. Smith Company, steam heating apparatus, Westfield, Mass., has decided to enlarge its plant.

It is said the Atlas Portland Cement Company will build a new foundry at its mills in Northampton, Pa.

The National Concrete Company of Dover, N. J., will put up a new factory at Horton Station, Morris county.

The Atlantic Refining Company, Philadelphia, Pa., has taken out a permit to build a $6000 machine shop.

The Marysville (Cal.) Gas and Electric Company will install an auxiliary plant at an expenditure of $12,000.

The Chas D. Kaier Company, Mahonay City, Pa., has commenced the erection of an ice manufacturing plant.

B. F. Everitt, manufacturer of automobile bodies and trimmings, Detroit, Mich., is having a new factory built.

The Hurty-Simmons Hardware Company, Minneapolis, Minn., will build a new plant at a cost of over $150,000.

The J. F. Ogden Hardware Company, New York, will erect a plant in Bayonne, N. J., to employ about 700 hands.

The Kennedy Valve Company, Coxsackie, N. Y., will build a large plant in Elmira, N. Y., to employ 400 men.

The Otto Gas Engine Works of Philadelphia will move to Wilmington, Del., where a larger plant will be erected.

The Roessler & Hasslacher Chemical Company of New York will invest $200,000 in a cyanide plant in Mexico City.

The National Radiator Company, Johnstown, Pa., will make improvements at its plant to cost almost $100,000.

The King Bridge Company, Cleveland, Ohio, will erect another factory building at its plant, also a temporary engine room.

The Cotton Belt Railway Company, will erect a car factory at Pine Bluff, Ark., to cost between $150,000 and $200,000.

The California Lumber and Furniture Company, West Berkeley, Cal., intends to install an almost complete line of new machinery.

The Inter-colonial Railway shops at Moncton, N. B., were burned entailing a loss of nearly $1,000,000. The shops will be rebuilt.

John Burchard Sons' Company, Perth Amboy, N. J., brass and iron founders, and machinists, will double the capacity of their shops.

The Lagonda Manufacturing Company, Springfield, Ohio, making boiler tube cleaners, will soon commence the erection of a new plant.

The door, sash and blind factory of the Barnes Manufacturing Company, Jersey City, N. J., was destroyed by fire. Loss about $75,000.

The Citizens Electric Light, Heat and Power Company, Perth Amboy, N. J., has awarded contract for the construction of its new plant.

The Burtt Manufacturing Company, Kalamazoo, Mich., manufacturing gasolene engines, auotmobiles, etc., will build a new plant.

Charles Waltz, 466 East Seventh Street, Oakland, Cal., has commenced the erection of a factory for the manufacture of safes and vaults.

The Yale & Towne Manufacturing Company, Stamford, Conn., manufacturing builders' hardware, has begun the erection of two additions.

The Bridgeport (Conn.) Silver Novelty Company has been incorporated. W. L. Bentley, Chas. A. Bentley, Mary A. Bentley, incorporators.

The Cockburn Barrow and Machine Company, Jersey City, N. J., will erect a new machine shop to be equipped with the most improved tools.

Jones & Laughlins Company of Pittsburg, Pa., has purchased land along the Ohio river, and it is said, will erect a large steel plant in the future.

Plans are being prepared for the enlargement of the plant of the Harvey Hubbell Company, Bridgeport, Conn., makers of tools and electrical specialties.

Estimates are being secured on the construction of the new plant of the Consumers' Electric Light & Power Company, recently organized at Hazleton, Pa.

Gottron Bros., Fremont, Ohio, lime manufacturers, contemplate many improvements, among which will be the installation of a modern stone crushing plant.

The Phoenix Foundry Company, St. Joseph, Mo., recently organized, is putting up a foundry to cost about $20,000. Henry Wilhelm and Robert Blum are interested.

The Merrimac Iron, Foundry of Lawrence, Mass., will erect an addition to its plant, which will consist of a main foundry, a power house and pattern shop.

Fire destroyed the warehouse and assembling room of the George N. Pierce Company, Buffalo, N. Y., automobile and bicycle manufacturers, causing a loss of about $500,000.

Fire in the central station of the San Francisco (Cal.) Gas and Electric Company, caused a loss estimated at nearly $1,000,000. for the manufacture of doors and windows.

The entire plant and equipment of the Poughkeepsie City & Wappinger Falls Electric Railway Co., at Poughkeepsie, N. Y., was destroyed by fire. Loss about $150,000.

The Spartan Cross Arm, Pin and Bracket Company has been formed at Spartanburg, S. C. Capital $10,000. D. L. Wray, an electrician of Spartanburg is promoting the company.

The Lidgewood Manufacturing Company, New York, has commenced the erection of a new plant, to cost about $500,000, at Waverly, N. J., for the manufacture of its conveyors, etc.

It is announced that the Pittsburg Reduction Company will move its plant from New Kensington, to Massena, N. Y., where a new plant to cost $100,000 will be built in addition to the present one.

The Sanitary Stopper Company, has been incorporated at Baltimore, Md., to manufacture patent rotary machines for cutting stoppers. J. Armstrong McNulty, Chas. H. Martin, etc., incorporators.

The Minnesota Peat Manufacturing Company has been incorporated in Minneapolis, Minn., and will erect a plant at Waseca, Minn. A. F Grant, O. A. Clark and R. P. Baker of Minneapolis, incorporators.

The American Zinc and Chemical Company, with headquarters in the Farmers Bank Building, Pittsburg, Pa., has awarded contracts for the reconstruction of its zinc plant at Utah Junction, near Denver, Colo. About $500,000 will be expended.

The Salem Iron Works, Winston-Salem, N. C., are in the market for a good pit or engine lathe of from 7 foot to 10 foot swing, and at least 6 feet between centers; also a vertical boring and turning mill of at least 6 foot swing. Larger sizes preferred. Second hand machines will answer if of modern design, in good order and at reasonable figures. Cuts or photographs of such machines are asked for with maker's name and full specifications as to condition, price etc.; also state where the machine is, so it can be examined if satisfactory.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Wanted—Punch Press that can not repeat. Any size. Box 301, AMER. MACH.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special machinery to order. Inventions developed. Geo. M. Mayer, M. E., 1131 Monadnock Bldg., Chicago, Ill.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under The Earle Gear and Machine Co., 141 Oxford st., Philadelphia, Pa.

Work Wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

A 40' span traveling crane having a capacity of 5000 to 6000 pounds; electrically driven both ways; arranged for 220 volts direct current. Address J. G. Brill Company, Philadelphia.

Canadian Agents Wanted—Large firm of machine tool makers, building turret lathes, automatic screw machines and horizontal and vertical milling machines, requires to meet with a first-class firm who will handle their line in Canada. Address, Box 297, AM. M.

Wanted—For large manufacturing concern in Illinois, first-class up-to-date man as foreman of machine shop, large department, fairly heavy work. Also a foreman of small blacksmith shop who would would be willing to run a fire himself when necessary. Engineering Agency, Monadnock Block, Chicago.

Well-known firm desires for Germany the sole agency for plain and universal Internal Grinding Machines 12 inches by 40 inches between centers, as well as for other modern machinery, viz., Automatic Screw Machines, etc. Address H. 3. 12377, care Haasenstein & Vogler A. G., Hamburg, Germany.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

Wanted—To hear from good reliable Company or individuals, regarding the development and constructing of any special machine or attachment. Familiar with steam, gas or air and special automatic machinery. Will also consider some standard special machine to build on orders. Address Capable, 292, AMERICAN MACHINIST.

Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 10 o'clock a. m., April 3, 1906, and publicly opened immediately thereafter, to furnish naval supplies as follows: Sch 399: One concrete mixer for delivery at the naval station, Guantanamo, Cuba.—Sch. 401: One engine lathe for delivery at the navy yard, New York, N. Y. Applications for proposals should designate the schedules desired by number. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y., or to the Bureau. H. T. B. Harris, Paymaster-General, U. S N. 2-27-06

For Sale.

For Sale—1000 Steam and Water gauges at $1 each. Send for list to J. L. Lucas, 2 Fox st., Bridgeport, Conn.

For Rent—Small factory at Plainfield; gasolene engine, railroad siding; $25 per month. A. J. Brunson, Plainfield, N. J.

Fore Sale—1—12 Point Waggoner Watchman's Clock, and 1—20 Point Waggoner Watchman's Clock. 32 Magneto boxes for same. All in first-class shape. Will sell at a reasonable price. If interested, address Purchasing Department, Olds Motor Works, Lansing, Mich.

Business Opportunities.

Office or mechanical man to invest $10,000 to $15,000 with services in growing foundry and machine shop controlling patent specialties, doubling its capacity the past 6 years. Good opportunity for young man. Address P. O. Box 1456, St. Louis, Mo.

A practical pattern maker with $1200 can secure the half interest of a retiring partner in a large pattern making shop in New York City, established nine years, netting $4500 per annum. Plant inventories $2300 and employs from 12 to 16 men. Remaining partner will consider only practical man. Address Partner, 283, AMERICAN MACHINIST.

A young man (29) who has had a technical education and eight years' experience selling machine and electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented on either salary or commission basis. Box 280, AMER. MACH.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Expert accountant and office manager desires position. Familiar with all branches of office work. References. P. O. Box 55, Hartford, Conn.

ILLINOIS.

Superintendent, of good executive, mechanical and inventive ability, experienced in manufacture of agricultural implements and general machinery, now employed, desires to better position. If you wish to improve construction, simplify operations or reduce cost of production, can give you results. Address 626 Monadnock Bldg., Chicago, Ill.

IOWA.

Chief Draftsman; a mechanical engineer, at present chief draftsman with a large manufacturing concern in the west. Box 269, AMERICAN MACHINIST.

MASSACHUSETTS.

Mechanical draftman, technical and practical experience desires position. Automatic or special machinery preferred. Address Box 304, AMERICAN MACHINIST.

NEW JERSEY.

Position desired by mechanical draftsman. Box 288, AMERICAN MACHINIST.

Draftsman—Young man desires position, 3 years shop and drafting experience. Box 290, AMERICAN MACHINIST.

Mechanical draftsman, well educated, age 30, graduate from French school, with machine shop and tool making experience, first-class in every respect, now open for engagement with reliable concern. Write to Louis D. Morand. P. O. Box 1457, Paterson, N. J.

NEW YORK.

Mechanical draftsman wishes position. Address Box 307, care AMERICAN MACHINIST.

Mechnical draftsman with several years shop and office experience wants position. Box 248. AMERICAN MACHINIST.

Designer and draftsman with several years experience on all kinds of steam boilers wants position. Box 284, AMER. MACHINIST.

Technical graduate, mechanical, Westerner, age 28, with shop and office experience, desires position that offers chance for advancement. Can handle men. Box 305, AM. M.

Experienced designer on machines for special purposes desires position in charge. Practical mechanic, technical, systematic, can handle help. Box 291, AMERICAN MACH.

Wanted by mechanical engineer, graduate (1904), position in engineering or testing department, engineering or manufacturing concern. M. E., Box 287, AMERICAN MACHINIST.

Mechanical draftsman, technical graduate; 2 years shop, 6 years drafting room experience detailing and designing in mechanical works, tube and general mill line. Box 286, AMERICAN MACHINIST.

Superintendent or manager—Steam engines or similar line; aggressive and systematic. Open for engagement at once. 15 years practical experience. Best of reasons for changing. Box 295, AMERICAN MACHINIST.

Mechanical engineer with executive ability, would like position as superintendent of factory. Will go anywhere. Technical graduate with shop experience. Thoroughly acquainted with shop systems. Have been designer of automatic and general machinery. Box 306, AMERICAN MACHINIST.

Mechanical engineer, college graduate, wishes to change. At present with prominent firm in power transmission machinery. Successful and well up in the commercial and selling end of the work. Wants responsible position. Address with full particulars, Box 293, AMERICAN MACHINIST.

OHIO.

As traveling salesman, a first-class toolmaker wants position handling machine tools or small tools of merit, age 28, hustler. Box 300, AMERICAN MACHINIST.

If your manufacturing cost is too high, place me in a leading position and I will locate and remedy the trouble, whether faulty design or poor shop methods. 14 years experience in drawing room and shop, designing, building and operating, engines, compressors and electrical machinery. Prefer eastern location. Box 296, AMERICAN MACH.

PENNSYLVANIA.

Mechanical engineer, technical graduate, 2 years shop practice and 6 years experience in designing steam engines, air compressors and pneumatic tools desires change. Box 289, AMERICAN MACHINIST.

Mechanical engineer, practical mechanic, 15 years experience in erection and operation of engines, pumps, boilers, sugar house machinery; also experienced in construction of steel and wooden structures, glass house furnaces and concrete foundations, desires a position of responsibility. Box 302, AMERICAN MACH.

WEST OF THE MISSISSIPPI.

Superintendent or tool-room foreman, technical education, 17 years experience on tools, scientific instruments and automatic machinery. Thorough on the interchangeable system. West or middle west preferred. Box 299, AMERICAN MACHINIST.

Superintendent or master mechanic, technical education, 15 years experience designing and machine shop practice on locomotives, marine engines, oil engines and electrical machinery, power plants. Colorado, Idaho, Utah or Nevada or the northwest preferred. Box 303, AMERICAN MACHINIST.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Tool-makers, experienced on gauge, fixture and die work. Appy Ross Rifle Company, Quebec, Canada.

CONNECTICUT.

Wanted—Two first-class tool-makers on small, accurate work. The Veeder Mfg. Co., Hartford, Conn.

First-class die sinkers accustomed to drop forged work. State experience and wages wanted. Kilborn & Bishop Co., New Haven, Conn.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—A man for foreman of assembling department in adding machine factory. Must be a thorough mechanic, successful in handling men, and with full experience in this class of work. State age, nationality, experience and salary wanted. Address Box 267, AMERICAN MACHINIST.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Draftsman well experienced in designing ring oiler bearing Only a first-class man will fill the requirement. B. F. Sturtevant Co., Hyde Park, Mass.

Wanted—Several machinists on small automatic machinery, tools and repair work. Permanent situation for competent men A-1 factory in Worcester County. Box 213, AM. M.

Wanted—Eight tool makers for light machine and tool work. Up to date factory with modern equipment. Permanent positions for right men. Works situated in Worcester County. State experience, age and wages expected. Box 211, AMERICAN MACH.

Wanted—Six die makers for small punching, forming and embossing dies and tools, in first-class shop with up-to-date machinery. Permanent situation if satisfactory. Factory in Central Mass. State age, experience and wages expected. Box 212, AMERICAN MACH.

Foreman for old established factory of brass goods and boiler supplies. Must be a first-class man who also understands how to make tools for manufacturing on a large scale. Must be able to produce results. Give detailed experience, references, age and wages expected. Address Box 285, AMER. MACH.

MICHIGAN.

Wanted—Ten first-class die makers. Experienced on drawing, forming and blanking dies. New Modern Shop. Good wages to good men. Inventors' Mfg. Co., Kalamazoo, Mich.

Wanted—Several first-class, experienced draftsmen, familiar with heavy engine designing. State wages desired and experience. Apply or address, Olds Gas Power Co., Lansing, Mich.

NEW JERSEY.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Experienced engine draftsmen wanted at once. Must be steady and accurate. Give full particulars. Ball & Wood Co., Elizabeth, N. J.

Mechanical draftsman on printing machinery wanted. One capable of taking charge of designing a machine. Box 247, AMER. MA.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—Mechanical draftsman for special machinery, jigs, tools. One with shop experience preferred. Address with reference, age, experience and salary expected. Box 228, AMERICAN MACHINIST.

NEW YORK.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Large electrical manufacturing company wishes experienced switchboard engineers and draftsmen. Reply Box 824, New York.

Wanted—A few A-1 tool-makers on punch and die work. Give references, age, and wages expected. None but first-class men need apply. Remington Typewriter Co., Ilion, N. Y.

Toolmakers—Wanted immediately, first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—A competent designing draftsman, with experience in centrifugal pumping machinery; state age, experience and salary expected; location New York State. Box 298, AMERICAN MACHINIST.

Draftsman on dies, jigs and fixtures for light, interchangeable work. Location Central New York. Position permanent to competent man. State previous experience and salary required. Box 258, AMER. MACH.

Machinists—For floor work. Permanent employment for good men. Wages $2.50 per day; 9 hour work day; time and half for overtime, double time for holidays. Location 25 miles from New York City. Box 268, AMERICAN MACHINIST.

Foreman wanted in manufacturing plant in New York City, man capable handling fifty men, must be systematic and a thorough all around mechanic, a knowledge of steam appliances is desirable, applicants should state age, and full particulars of experience. Salary, $1600. Box 294, AMER. MACHINIST.

Wanted—Experienced tool steel salesman to cover respectively Chicago territory, Cleveland territory, Pacific coast, also Eastern States, having an established trade with the large manufacturing concerns, machine and railroad shops. Must have a practical knowledge of working tools, hardening and tempering high-speed and carbon steels. State full particulars and salary expected. References. Tool Steel 308, AMER. MACHINIST.

OHIO.

Wanted—First-class mechanical draftsmen, experienced in machine tool work. The Niles Tool Works Co., Hamilton, Ohio.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 270, AMERICAN MACH.

Wanted—First-class man to take charge of designing of up-to-date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of the same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted.—First-class instrument and toolmakers; also large machine tool operators. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

The Monotype Company maintains a school to train young men to meet the constantly increasing demand for operators of its type casting and composing machine. These operators have done so well that it receives more applications for places than can be filled. In making selections these qualifications carry most weight; common sense, type-foundry experience, printing office experience, automatic machinery experience. Full particulars will be furnished to inquirers who furnish the same information about themselves. The Lanston Monotype Machine Co., 1231 Callowhill St., Phila., Pa.

RHODE ISLAND.

Machinist Wanted.—A reliable young man in Eastern City to work on tools and take charge of small job. Good wages and steady work to the right man. Box 259, AM. M.

Toolmakers Wanted.—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Wanted—Machinists ambitious to be foremen or sub-foremen. Our growing automobile business often furnishes opportunity for advancement. Thomas B Jeffrey & Co., Kenosha, Wis., Rambler Automobiles.

Large concern building excavating and rail-

way machinery wants to correspond with first-class mechanical draftsmen, with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters, acknowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Wanted.—General Superintendent to take charge of factory employing three-hundred hands; one having had experience in making typewriters or adding machines preferred. Give experience, references and salary expected. Box 275, AMERICAN MACHINIST.

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"Presto" Chucks, Collets and Friction Tapping Devices
Sprockets for "Wizard" Chains
Hartford Printer.

Patented.

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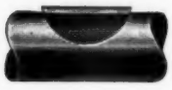

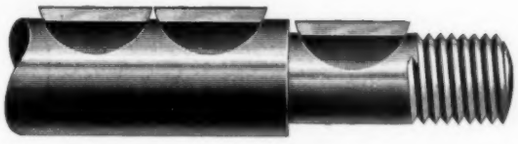

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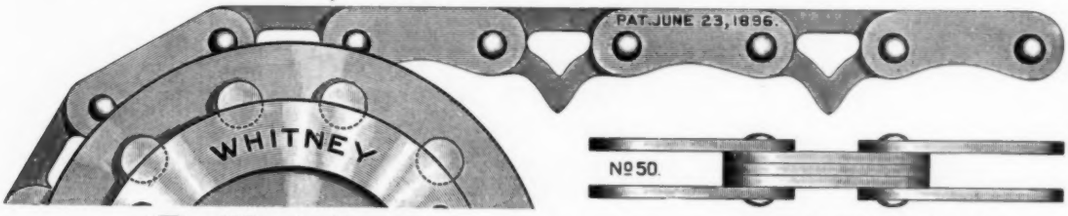

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"Wizard" Chain, Patented.

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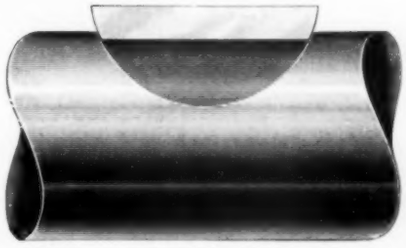

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Pawling & Harnischfeger, Milwaukee, Wis.
Sellers & Co., Wm., Phila., Pa.
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Yale & Towne Mfg. Co., New York.

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Link-Belt Engineering Co., Philadelphia, Pa

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Nutter, Barnes & Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

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Pratt & Whitney Co., Hartford, Conn.

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Kent & Co., Edwin R., Chicago, Ill.

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Barnes Co., W. F. & John, Rockford, Ill.
Boynton & Plummer, Worcester, Mass.
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Ingersoll-Rand Co., New York.
McGeorge & Sons, Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Sloane & Chace Mfg. Co., Newark, N. J.

Drilling Machines, Boiler
American Tool Wks. Co., Cin., O.
Aurora Tool Works, Aurora, Ind.
Bickford Drill & Tool Co., Cincinnati, O.
Boynton & Plummer, Worcester, Mass.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

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American Tool Wks. Co., Cin., O.
Baker Bros., Toledo, O.
Barnes Co., B. F., Rockford, Ill.
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Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
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Fenn-Sadler Mach. Co., Hartford, Conn.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Garvin Mach. Co., New York.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mchy. Co., Chicago, Ill.
McCabe, J. J., New York.
Newton Mach. Tool Works, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Three Rivers Tool Co., Three Rivers, Mich.

Drilling Machines, Portable
Cincinnati Elec. Tool Co., Cin., O.
Coates Clipper Mfg. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drilling Machines, Radial
American Tool Wks. Co., Cin., O.
Baush Mach. Tool Co., Springfield, Mass.
Bickford Drill & Tool Co., Cincinnati, O.
Detrick & Harvey Mach. Co., Baltimore, Md.
Dreses Mach. Tool Co., Cin., O.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Foote, Burt & Co., Cleveland, O.
Fosdick Mach. Tool Co., Cin., O.
Gang Co., Wm. E., Cincinnati, Ohio.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hill, Clarke & Co., Boston, Mass.
Marshall & Huschart Mach. Co., Chicago, Ill.
McCabe, J. J., New York.
Morris Fdry. Co., Jno. B., Cincinnati, Ohio.
Mueller Mach. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Vandyck Churchill Co., New York.

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Niles-Bement-Pond Co., New York.

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American Tool Wks. Co., Cin., O.
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Barnes Co., W. F. & John, Rockford, Ill.
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Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Boynton & Plummer, Worcester, Mass.
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Dwight Slate Machine Co., Hartford, Conn.
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Fenn-Sadler Mach. Co., Hartford, Conn.
Fosdick Mach. Tool Co., Cincinnati, O.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Hill, Clarke & Co., Boston, Mass.
Hoefer Mfg. Co., Freeport, Ill.
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Sellers & Co., Inc., Wm., Philadelphia, Pa.
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Sloane & Chace Mfg. Co., Newark, N. J.
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Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

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Morse Twist Drill & Mach. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Slocomb Co., J. T., Providence, R. I.
Standard Tool Co., Cleveland, O.

Drills, Hand
Cincinnati Electrical Tool Co., Cincinnati, O.
Hisey-Wolf Mach. Co., Cincin., O.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Drills, Pneumatic
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Cleveland Pneu. Tool Co., Cleveland, O.
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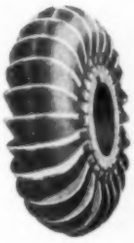

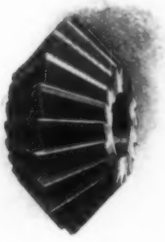

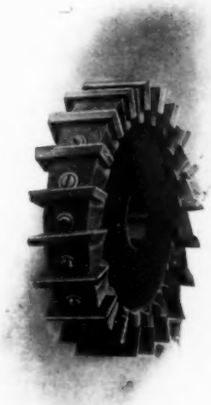

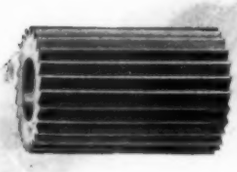

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Standard Tool Co., Cleveland, O.

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Curtis & Curtis Co., Bridgeport, Conn.
Hisey-Wolf Mach. Co., Cincin., O.
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Pratt & Whitney Co., Hartford, Conn.
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Northern Elec. Mfg. Co., Madison, Wis.
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Sprague Elec. Co., New York.
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Jantz & Leist Elec. Co., Cin., O.
Northern Elec. Mfg. Co., Madison, Wis.
Roth Bros., Chicago, Ill.
Sprague Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Triumph Elec. Co., Cincinnati, O.
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Engines, Steam
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Sprague Elec. Co., New York.
Stanley G. I. Electric Mfg. Co., Pittsfield, Mass.
Sturtevant Co., B. F., Hyde Park, Mass.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

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Ingersoll-Rand Co., New York.
Miner & Peck Mfg. Co., New Haven, Conn.
Patterson, Gottfried & Hunter, Ltd., New York.

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Slocomb Co., J. T., Prov., R. I.
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Lunkenheimer Co., Cincinnati, O.

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Brown & Sharpe Mfg Co., Providence, R. I.
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Eberhardt Bros. Mach. Co., Newark, N. J.
Fellows Gear Shaper Co., Springfield, Vt.
Ganschow, Wm., Chicago, Ill.
Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.

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Newton Mach. Tool Wks., Philadelphia, Pa.
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Pratt & Whitney Co., Hartford, Conn.
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Sloane & Chace Mfg. Co., Newark, N. J.
Walcott & Son, Geo. D., Jackson, Mich.
Whiton Machine Co., D. E., New London, Conn.

Gear Testing Machinery
Gisholt Mach. Co., Madison, Wis.
Morse Twist Drill & Mach. Co., New Bedford, Mass.

Gears, Cut
Bilgram, Hugo, Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Davis, Rodney, Philadelphia, Pa.
Earle Gear & Mach. Co., Philadelphia, Pa.
Eberhardt Bros. Mach. Co., Newark, N. J.
Eickemeyer Mfg. Co., Yonkers, N. Y.
Fawcus Mch. Co., Pittsburg, Pa.
Fellows Gear Shaper Co., Springfield, Vt.
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Gleason Works, Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Horsburgh & Scott Co., The, Cleveland, O.
James, D. O., Chicago, Ill.
Massey Mach. Co., Watertown N. Y.
Morse, Williams & Co., Phila., Pa.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Patterson, Gottfried & Hunter, Ltd., New York.
Philadelphia Gear Works, Philadelphia, Pa.
Sawyer Gear Wks., Cleveland, O.
Simonds Mfg. Co., Pittsburg, Pa.
Syracuse Raw Hide Mfg. Co., Syracuse, N. Y.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
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Gears, Molded
Caldwell & Son Co., H. W., Chicago, Ill.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Franklin Mfg. Co., Syracuse, N. Y.
Greenwald Co., I. & E., Cin., O.
Philadelphia Gear Wks., Philadelphia, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Gears, Rawhide
Boston Gear Wks., Boston, Mass.
Chicago Raw Hide Mfg. Co., Chicago, Ill.
Fawcus Mch. Co., Pittsburg, Pa.
Gould & Eberhardt, Newark, N. J.
Horsburgh & Scott Co., The, Cleveland, Ohio.
New Process Raw Hide Co., Syracuse, N. Y.
Nuttall Co., R. D., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Syracuse Raw Hide Co., Syracuse, N. Y.

Gears, Worm
Albro-Clem Elevator Co., Philadelphia, Pa.
Boston Gear Wks., Boston, Mass.
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Gould & Eberhardt, Newark, N. J.
Grant Gear Works, Boston, Mass.
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Morse Williams & Co., Phila., Pa.
Nuttall Co., R. D., Pittsburg, Pa.
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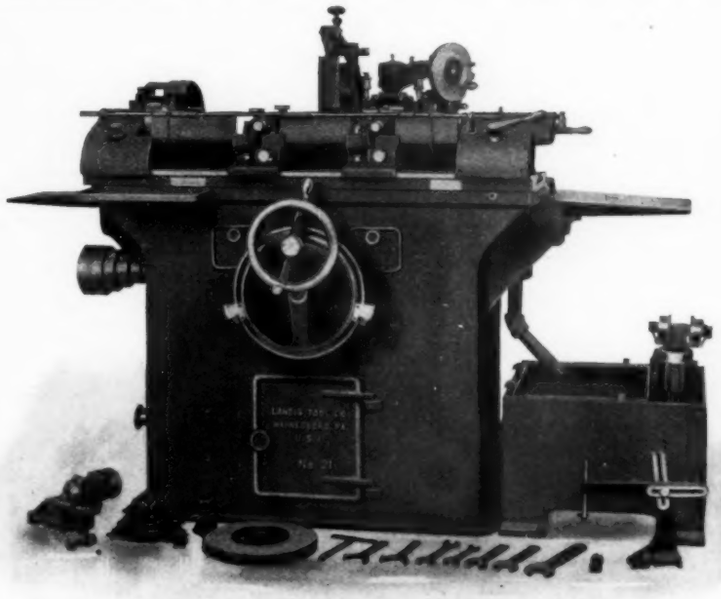

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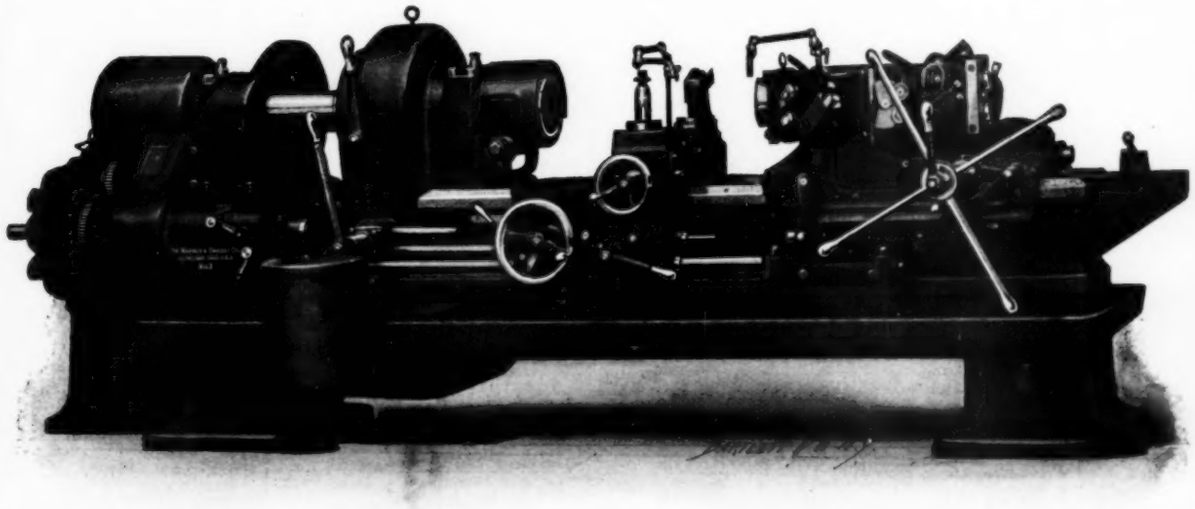

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Coates Clipper Mfg. Co., Worcester, Mass.
Heald Mch. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.
Mueller Mch. Tool Co., Cin., O.
Niles-Bement-Pond Co., New York.
Rivett-Dock Co, Boston, Mass.

Grinders, Cock
Windsor Mach. Co., Windsor, Vt.

Grinders, Cutter
Bath Grinder Co., Fitchburg, Mass.
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Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mach. Co., Cincinnati, O.
Crocker-Wheeler Co., Ampere, N. J.
Dayton Machine & Tool Works, Dayton, O.
Garvin Machine Co., New York.
Gould & Eberhardt, Newark, N. J.
Greenfield Mach. Co., Greenfield, Mass.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., New York.
Niles-Bement-Pond Co., New York.
Norton Emery Wheel Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Rivett-Dock Co., Boston, Mass.
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Heald Mach. Co., The, Worcester, Mass.,
Norton Grinding Co., Worcester, Mass.

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Heald Machine Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Iroquois Mach. Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.

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Hill, Clarke & Co., Boston, Mass.
Niles-Bement-Pond Co., New York.
Standard Tool Co., Cleveland, O.
Wilmarth & Morman Co., Grand Rapids, Mich.

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Brown & Sharpe Mfg. Co., Providence, R. I.
Greenfield Mach. Co., Greenfield, Mass.

Grinders, Internal—*Con't.*
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Wells & Sons Co., F. E., Greenfield, Mass.

Grinders, Piston Ring
Heald Mach. Co., Worcester, Mass.

Grinders, Portable
Cincinnati Electrical Tool Co., Cincinnati, O.
Heald Mach. Co., Worcester, Mass.
Hisey-Wolf Mach. Co., Cincin., O.

Grinders, Tool
Armstrong Bros. Tool Co., Chicago, Ill.
Barnes Co., W. F. & John, Rockford, Ill.
Bath Grinder Co., Fitchburg, Mass.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Electrical Tool Co., Cincinnati, O.
Diamond Mach. Co., Prov., R. I.
Dwight Slate Machine Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Gould & Eberhardt, Newark, N. J.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Heald Mach. Co., Worcester, Mass.
Hill, Clarke & Co., Boston, Mass.
Hisey-Wolf Mach. Co., Cincinnati, O.
Landis Tool Co., Waynesboro, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Ransom Mfg. Co., Oshkosh, Wis.
Rivett Lathe Mfg. Co., Boston, Mass.
Safety Emery Wheel Co., Springfield, O.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Vandyck Churchill Co., New York.
Whitney Mfg. Co., Hartford, Ct.

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Bath Grinder Co., Fitchburg, Mass.
Besly & Co., Chas. H., Chicago, Ill.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
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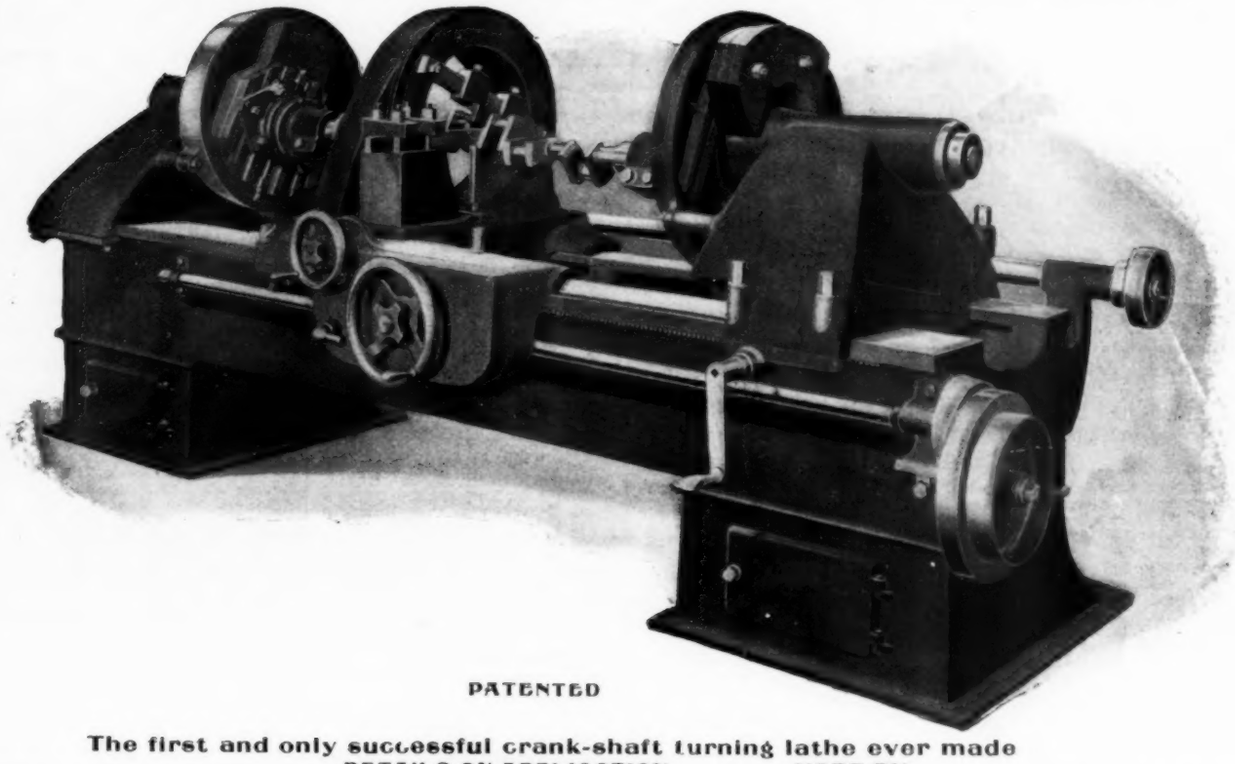

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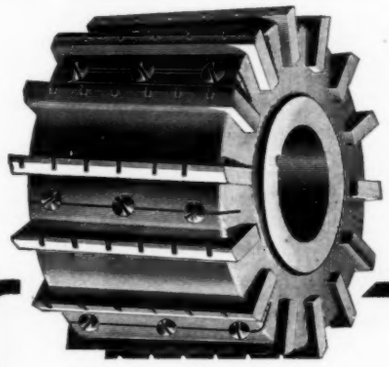

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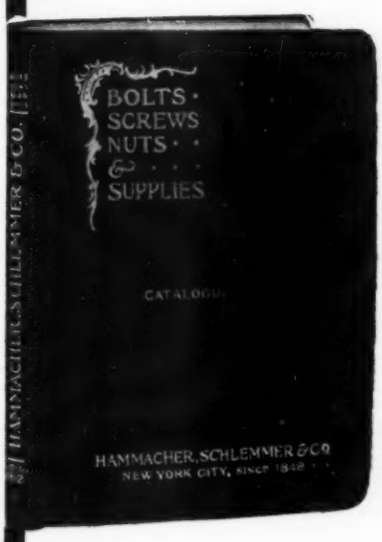

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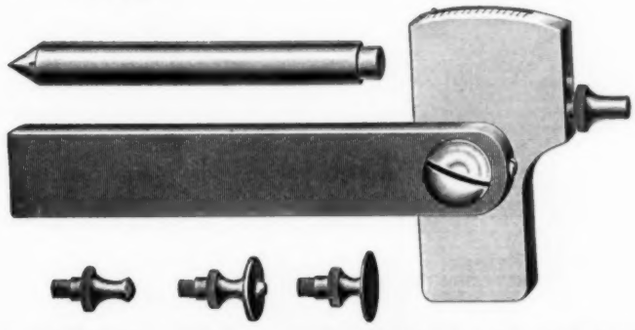

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Dixon Crucible Co., Jos., Jersey City, N. J.

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American Watch Tool Co., Waltham, Mass.
Gould & Eberhardt, Newark, N. J.
Sloane & Chace Mfg. Co., Newark, N. J.

Pipe Cutting and Threading Machines
Bignall & Keeler Mfg. Co., Edwardsville, Ill.
Curtis & Curtis Co., Bridgeport, Conn.
Merrell Mfg. Co., Toledo, O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Saunders' Sons, D., Yonkers, N. Y.
Standard Engineering Works, Ellwood City, Pa.
Stoever Fdry. & Mfg. Co., Myerstown, Pa.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.
Wells Bros. Co., Greenfield, Mass.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Pipe Fitters' Tools
Cleveland Twist Drill Co., Cleveland, O.
Saunders Sons, D., Yonkers, N. Y.
Standard Tool Co., Cleveland, O.

Planer Attachments
Cincinnati Planer Co., Cin. Ohio.
Gray Co., G. A., Cincinnati, O.

Planers
American Tool Wks. Co., Cin.. O.
Bartlett, E. E., Boston, Mass.
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Betts Mach. Co., Wilmington, Del.
Bilgram, Hugo, Philadelphia, Pa.
Cincinnati Planer Co., Cincin., O.
Cleveland Planer Works, Cleveland, O.
Detrick & Harvey Mch. Co., Baltimore, Md.
Fairbanks Co., New York.
Fitchburg Machine Works, Fitchburg, Mass.
Garvin Mach. Co., New York.
Gray Co., G. A., Cincinnati, O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Hendey Mach. Co., Torrington, Ct.
McCabe, J. J., New York.
Motch & Merryweather Machinery Co., Cleveland, O.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Sellers & Co., Wm., Phila., Pa.
Vandyck Churchill Co., New York.
Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass.
Woodward & Powell Planer Co., Worcester, Mass.

Planers, Portable
Morton Mfg. Co., Muskegon Heights, Mich.
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Planers, Rotary
Newton Mach. Tool Wks., Philadelphia, Pa.
Niles-Bement-Pond Co., New York.
Underwood & Co., H. B., Philadelphia, Pa.

Powders, Tempering and Welding
Phillips-Laffitte Co., Phila., Pa.

Precision Machinery
American Watch Tool Co., Waltham, Mass.
Faneuil Watch Tool Co., Boston, Mass.
Rivett Lathe Mfg. Co., Boston, Mass.
Stark Tool Co., Waltham, Mass.

Presses, Broaching
Prentiss Tool & Supply Co., New York.
Watson-Stillman Co., New York.

Presses, Drop
American Tube & Stamping Co., Bridgeport, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.

Presses, Foot and Hand
Bliss Co., E. W., Brooklyn, N. Y.
Phoenix Iron Works Corp., Hartford, Conn.

Presses, Forging
Niles-Bement-Pond Co., New York.

Presses, Hydraulic
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Watson-Stillman Co., New York.

Presses, Power
American Tube & Stamping Co., Bridgeport, Conn.
Automatic Mach. Co., Bridgeport, Conn.
Bethlehem Fdry. & Mach. Co., So. Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., Brooklyn, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Dill Machine Works, T. C., Philadelphia, Pa.
Fairbanks Co., New York.
Lucas Mach. Tool Co., Cleve., O.
Niles-Bement-Pond Co., New York.
Prentiss Tool & Supply Co., New York.
Springfield Mach. Tool Co., Springfield, O.
Vandyck Churchill Co., New York.
Waterbury Farrel Fdry. & Mach. Co., Waterbury, Conn.

Presses, Screw
Barnes Co., W. F. & Jno., Rockford, Ill.

Profilers
Amercian Watch Tool Co., Waltham, Mass.
Becker-Brainard Mill Mach. Co., Hyde Park, Mass.
Garvin Mach. Co., New York.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.

Publishers
Henley Pub. Co., Norman W., New York.

Pulleys
American Pulley Co., Phila., Pa.
American Tool & Machine Co., Boston, Mass.
Caldwell & Son Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Eastern Machinery Co., New Haven, Conn.
Fitchburg Machine Works, Fitchburg, Mass.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., New York.
Reeves Pulley Co., Columbus, Ind.
Rockwood Mfg. Co., Indianapolis, Ind.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Wood's Sons Co., T. B., Chambersburg, Pa.
Wilmarth & Morman Co., Grand Rapids, Mich.

Pulley Turning and Boring Machines
American Tool Wks. Co., Cin., O.
Harrington, Son & Co., Edwin, Philadelphia, Pa.
Niles-Bement-Pond Co., New York.

Pumps, Air
Ingersoll-Rand Co., New York.

Pumps, Electric
General Electric Co., New York.

Pumps, Hydraulic
General Electric Co., New York.
Watson-Stillman Co., New York.

Pumps, Steam
Ingersoll-Rand Co., New York.
International Steam Pump Co., New York.

Punches, Centering
Brown & Sharpe Mfg. Co., Providence, R. I.
Hammacher, Schlemmer & Co., New York.
Niagara Mach. & Tool Wks., Buffalo, N. Y.

Punches, Hydraulic
Bethlehem Fdry. & Hch. Co., So. Bethlehem, Pa.
Niles-Bement-Pond Co., New York.
United Engineering & Fdry. Co., Pittsburg, Pa.
Watson-Stillman Co., New York.
Prentiss Tool & Supply Co., New

Punches, Power
Bertram & Sons Co., Ltd., John, Dundas, Ont., Canada.
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Bliss Co., E. W., Brooklyn, N. Y.
Hilles & Jones Co., Wilmington, Del.
Long & Allstatter Co., Hamilton, Ohio.
Niles-Bement-Pond Co., New York.
United Engineering & Fdry. Co., Pittsburg, Pa.
Vandyck Churchill Co., New York.

Rack Cutting Machines
Adams Co., Dubuque, Iowa.
Dwight Slate Machine Co., Hartford, Conn.
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
Le Blond Mach. Tool Co., R. K., Cincinnati, O.
Walcott & Son, Geo. D., Jackson, Mich.

Racks, Cut
Boston Gear Wks., Boston, Mass.
Fellows Gear Shaper Co., Springfield, Vt.
Gould & Eberhardt, Newark, N. J.
LeBlond Mach. Tool Co., R. K., Cincinnati, Ohio.
Nuttall Co., R. D., Pittsburg, Pa.
Simonds Mfg. Co., Pittsburg, Pa.
Philadelphia Gear Works, Philadelphia, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Taylor-Wilson Mfg. Co., Allegheny, Pa.
Walcott & Son, Geo. D., Jackson, Mich.

Racks, Tool
Mfg. Equip. & Engrg. Co., E. Boston, Mass.
Massey Mach. Co., Watertown, N. Y.
New Britain Mch. Co., New Britain, Conn.

Radiators, Japanning Oven
American Gas Furnace Co., New York.

Reamers
Boker & Co., Hermann, New York.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Chadwick & Co., G. B., Portsmouth, N. H.
Cleveland Twist Drill Co., Cleveland, O.
Clough, R. M., Tolland, Conn.
Gisholt Mach. Co., Madison, Wis.
Hammacher, Schlemmer & Co., New York.
International High Speed Steel Co., New York.
Lapointe Mach. Tool Co., Boston, Mass.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
New Process Twist Drill Co., Taunton, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rogers Works, John M., Gloucester City, N. J.
Schellenbach & Radcliffe, Cin., O.
Standard Tool Co., Cleveland, O.
Wells Bros. Co., Greenfield, Mass.
Whitman & Barnes Mfg. Co., Chicago, Ill.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Reheaters, Steam
Ingersoll-Rand Co., New York.

Rheostats
Crocker-Wheeler Co., Ampere, N. J.
Cutler-Hammer Clutch Co., Milwaukee, Wis.
General Elec. Co., New York.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Rims and Bands
Standard Welding Co., Cleve., O.

Rings, Chuck and Gear
Standard Welding Co., Cleve., O.

Riveters, Hydraulic
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Niles-Bement-Pond Co., New York.
Watson-Stillman Co., New York.

Riveters, Pneumatic
Chisholm & Moore Mfg. Co., Cleveland, Ohio.
General Pneumatic Tool Co., Montour Falls, N. Y.
Ingersoll-Rand Co., New York.
Niles-Bement-Pond Co., New York.

Methods of A Modern Vehicle-Axle Plant.

BY CHAS. A. TRASK.

The methods in vogue in a modern axle factory present problems of more than ordinary interest, particularly when the speed of production coupled with the comparative accuracy of the product is taken into consideration.

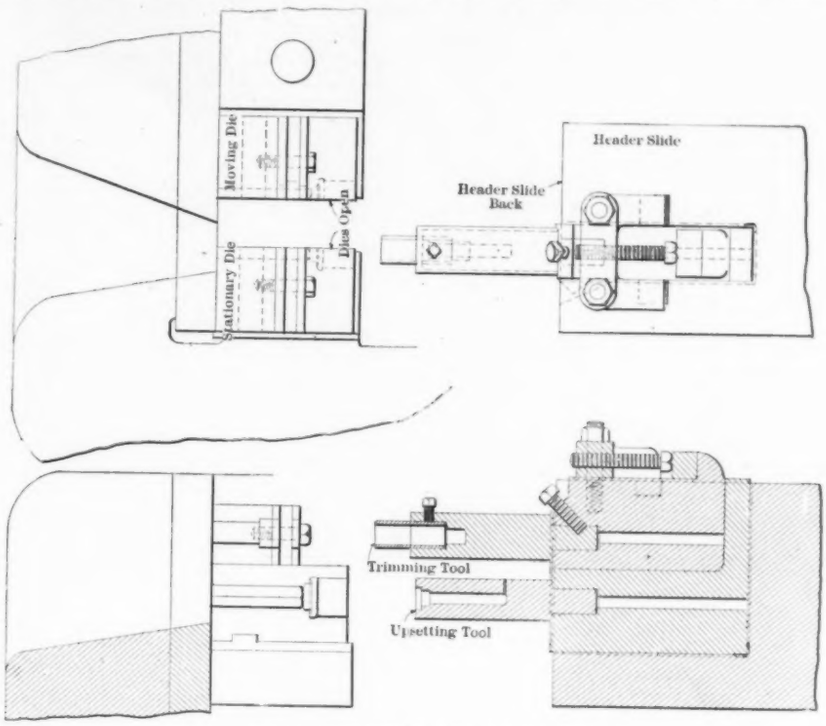

FIG. 1. UPSETTING AND SIZING TOOLS.

The plant in which I took my observations—that of the Lewis Spring and Axle Company, of Jackson, Mich., where I was courteously given the freedom of the works—is divided into two departments, the forge shop in which the stock is prepared for turning, etc., and the finishing department where the parts are finished and assembled.

For the benefit of the uninitiated, it should be stated here that the round part of the axle on which the wheel turns is called the "arm" while the square or flat part is called the "bed." A "set" means four except in the case of a "one-piece" axle when a "set" would mean two.

OPERATIONS PREPARATORY TO TURNING.

In this factory axles from ⅞ inch to 2½ inches square are made. The stock is first cut to length; this operation has to be done with reasonable accuracy, as the finished length of a one-piece axle depends upon a correct amount of stock at the start. While 30,000 sets of one-piece axles—a single order—were going through, at the time of my visit, still about 60 per cent. of the output are made in halves and welded by the purchaser.

The bars are first heated for about 8 inches on one end, in a furnace in which crude oil is used as fuel, the waste or surplus heat being conducted to a boiler that furnishes steam for the engine that runs the plant. About 25 ends are heated at once. The pieces—in this case 1⅛ inches square—are first reduced by four passes through the usual tapering rolls; this rounds the square bar for about 7 inches of its length, tapering from about ⅞ inch on the end to 1 inch where it begins to round. While still hot the work is passed to the "Ajax" upsetting and sizing machine, top and sectional views of the operating parts of which are shown in Fig. 1. This machine has capacity for sizing the arm and upsetting a collar 4 inches in diameter and 1½ inches thick on 2½ inch square stock. In this case, however, with the 1⅛ inch square stock it has a comparatively easy task, viz: sizing the already rounded end and upsetting a collar 2½ inches in diameter and 1 inch thick, and the "swell" 1⅜ inches in diameter 1¼ inches long, at the first stroke, and trimming off the slight flash or extrusion at the second. The output of two men on these machines is from 400 to 500 sets per day, the work done being remarkably uniform and shapely.

The next operation consists of drawing out the bed to the desired shape; in the case under observation they were "fan tailed" ⅞ inch square close to the collar, 1¼x13/16 inch at the end, one side being rounded. This work was being expeditiously done on a "Yeakley" hammer, built by Williams, White & Company, Moline, Ill., and shown in Figs. 2, 3 and 4.

A PNEUMATIC HAMMER.

A unique principle of this machine consists in the fact that there are no piston rods, springs or connections of any kind for attaching the ram or hammer head, weighing in this case about 400 pounds, to any other part of the machine. The ram or hammer head is a rectangular hollow block of steel sliding vertically in a closely fitting chamber, being sucked up by vacuum and thrown down alternately by the forcible injection of the air into the ram chamber above the ram. The force of the blow is also greatly increased by the compression of air in the upper part of the chamber when running at full stroke. By referring to the half-tone it will be noted that there is an air cylinder at the back of the machine, which is part of the main frame. The piston and rod are driven by a crank-shaft which in turn is driven by belt. The hammer head makes

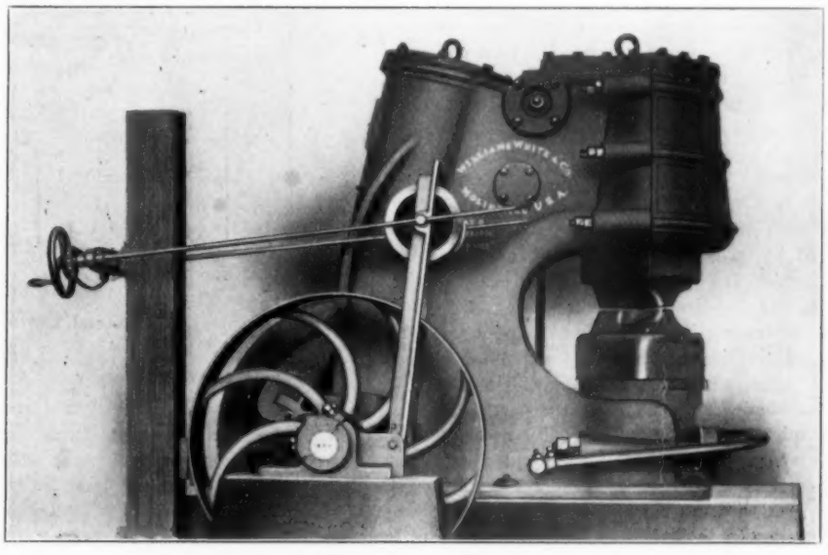

FIG. 2. A PNEUMATIC HAMMER.

one stroke for every stroke of the air piston. Between the air cylinder and the ram chamber is a valve, the operation of which is shown in Figs. 3 and 4.

The letters designating the various parts are as follows: *A*, air chamber; *B*, ram chamber; *C*, bushing in the valve chamber; *D*, rotating or operating valve; *E*, port from the air cylinder to the valve chamber; *F*, port from the valve chamber to the ram chamber; *G*, port from *F* to top of ram chamber; *H*, leather valve over port *G*; *I*, *J*, *K*, *L*, *M*, openings in the rotating or operating valve; *N*, port from valve chamber to the expansion chamber in the main frame of the machine; *O*, expansion chamber.

OPERATION OF THE HAMMER.

In operating the hammer, when the piston is in operation and the hammer idle, the valve will be in the position shown in Fig. 4. The air when compressed by the piston in the air cylinder, passes into and through the valve chamber and into the expansion chamber *O* through the opening *K* and port *N*. For the downward stroke of the air piston this air is expanded and drawn out of chamber *O* through port *N* and opening *K* of the valve and port *E* and also out of the ram chamber through the port *F* and opening *J* in the rotating valve. This tends to hold the top end of the ram at about the line of the top edge of port *F* in the ram chamber. The ram will remain in that position as long as the valve is in the position shown in Fig. 4.

To operate the hammer or to strike a blow, the treadle is depressed, rotating the valve in the direction shown by the arrow marks from the position shown in Fig. 4 to that in Fig. 3, when the ram will be striking a full stroke. Medium blows can be struck by rotating the valve to some position between those indicated in the two views. The function of valve *H* over port *G* is to prevent the air escaping from the top of he ram chamber when the ram is striking a blow. To strike one dead blow or to hold the dies together, the valve is rotated from the position in Fig. 3 in the direction of the arrow marks by depressing the treadle until the opening *L* in the valve is opposite port *E*. The ram will then have only compression above it, as the suction in the air cylinder causes the leather valve over the port *L* to seat tightly, thereby cutting off the vacuum from the ram chamber. This will let the ram remain down as long as the treadle is held in that position, but as soon as the treadle is released, the ram will return to its highest point, which as noted before, would be about the top line of the port *F*.

Fig. 5 is a view looking at the row of hammers; the one in the foreground is evidently finishing an axle, as the shower of water is distinctly shown. This is not turned on until the piece is approaching finished size. These four hammers, when I saw them, were in operation with one man and one helper on each, the axles being heated in furnaces like that described above. The hammers were running at 140 strokes per minute and about 190 blows were struck on each piece, which lengthened it from 20½ to 29 inches, measuring from the collar to the end. They were then straightened by the helper, being raised and dropped on an anvil, a hammer being used very little.

The hammered part is beautifully smooth, being entirely free from scale, and while nothing was used on the anvil to prevent hammering the work too small, as is frequently seen in use on heavy steam hammers, the work was as accurate to size as an ordinary commercial bar of square iron.

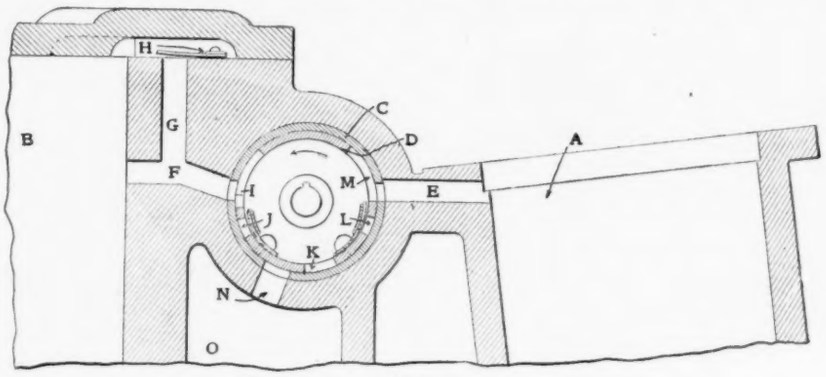

FIG. 3

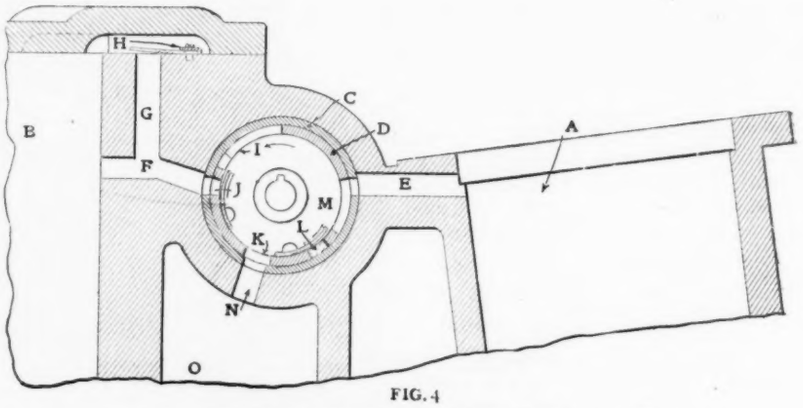

FIG. 4

SECTIONS THROUGH HAMMER VALVE.

A SPECIAL AXLE LATHE.

In the finishing department the first operation is to see that the axles are straight enough to be machined; the arms are then turned in a special lathe called by the makers (Spears & Riddle, of Wheeling, W. Va.) a "triple axle ram." This lathe is shown in Fig. 6 and has 3 hollow spindles about 5 inches diameter, carried in a large drum about 28 inches diameter. On the back end of each spindle is a gear 14½ inches diameter, 2½ inches face, 4 pitch; these three gears engage a 4¾-inch central pinion, which is keyed to the shaft on which is carried the driving clutch pulley shown, which is 16 inches diameter for a 6-inch belt. The spindles run at a speed of 110 turns per minute, no provision being made for any other speed. The chucks are provided with four screws, and I noticed that only one was being used by the operator; one was backed out of the way, the other two not being disturbed. As practically all the axles are square where they pass through the chuck, there is little danger of their turning; the principal strain to guard against is the thrust of the tools, for when turning one-piece axles, the limit of error allowed is ⅛ inch in length.

One-piece axles are passed into the spindle from the back end. The gage above the chuck and arm is swung forward to the position shown; this enables the operator to set the axles in the correct position lengthwise. The chuck screw is tightened, and the pedal near the floor depressed; this engages the mechanism that revolves the entire drum and automatically stops it when it has turned 120 degrees. The operator now engages the 16-inch clutch pulley and depresses the lever, admitting the water to the cylinder on the right, through the 1¼-inch pipe. The piston in this cylinder is connected direct to the carriage by the piston rod. The water pressure carried is 90 lb., which promptly brings the carriage with its three box tools forward. Just before the tools begin cutting the supply of water is automatically cut off; the operator then admitting the water through a ¼-inch pipe and valve instead of through the 1¼-

inch pipe; this furnishes the feed while the axles are being turned.

ARRANGEMENT OF TOOLS.

The lower rear box tool roughs the arm nearly to size, while the lower front one finishes. The upper one, however,

FIG. 5. A GROUP OF HAMMERS.

is not fastened solidly to the carriage, as is the case with the first two, but is arranged to slide about 2 inches to the left, being normally held in this position by a spring. As the axle enters the tool head, and when the carriage is within 1½ inches of its extreme movement to the left, an adjustable stop comes in contact with the end of the axle, arresting the forward movement of the tool, and retaining it in position while the two lower tools are advancing and doing their work. As soon as the forward movement of this upper tool head ceases, the operator turns the hand-wheel shown, advancing three tools, one of which turns the outside of the collar at *A*, Fig. 7, one squares the face of the collar at *B* and cuts the groove *C*; the other faces the shoulder which allows the nut *D* to come up square. During these operations the tools are flooded with a drilling compound. The arms are now smooth and all very uniform. Of a large number calipered at random the smallest found was less than 0.00075 inch smaller than the largest.

The operator on one of these machines is considered one of the most rapid axle turners in America. The week before my visit he turned out 790 sets, which at 5 cents per set makes some of us feel like ranging up alongside of our college professors who have lately been comparing their salaries with those received by baseball players and foot-ball coaches. The average man, however, turns out about 500 sets per week.

RECESSING, CENTERING AND FILING.

In order to turn the recess shown in the face of the collar, the axle is driven into a socket in a lathe spindle. These lathes have no tailstock as none is needed. After the recess is cut the axle is driven out. The spindle being hollow, a heavy rod runs through it, projecting at the back; and on a rough wrought-iron framework is a heavy hammer rigged in line with the spindle and operated by a handle reaching along in front of the headstock so that the operator drives the axle out with a smart blow or two, without leaving his position. The carriage on the lathe is handled by a large pilot wheel. One man recesses about 200 sets per day. The ends are threaded in an ordinary bolt cutter, half right hand and half left. The oil grooves are milled four at a time in millers of the Lincoln type, the clamping device used to hold the work being operated by one lever.

Filing is the next operation and the only one where the axle is mounted on centers, it being centered by hand. A socket is first slipped over the end of the axle, having a hole in which a center punch fits; one blow of the hammer suffices. Very little filing is necessary on account of the excellence of the lathe work. Great care is taken to have all axles conform to a standard, hardened and ground arbors being used to this end, to which are carefully fitted master boxes into which every axle is tried before being assembled; those that are too large are returned to the filers to be lapped down, while those too loose are rejected.

REAMING BOXES.

The boxes—excellent gray-iron castings entirely free from sand or scale—are of the form shown in Fig. 8 and are first reamed in the four-spindle box-reaming machine, Fig. 9. Fastened to the rotary

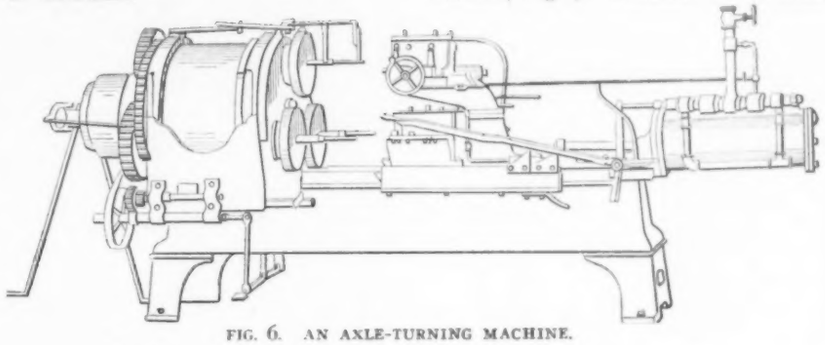

FIG. 6. AN AXLE-TURNING MACHINE.

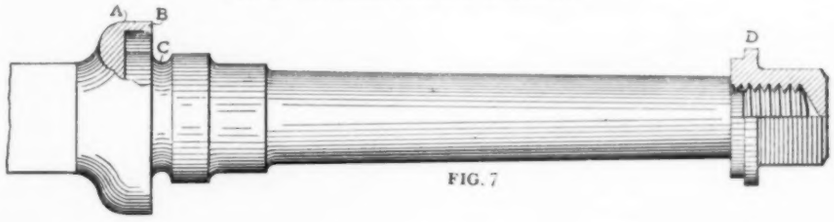

FIG. 7

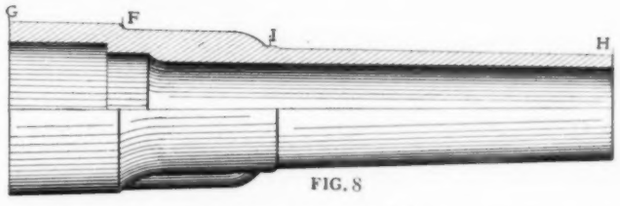

FIG. 8

AXLE-ARM AND BOX.

table are 10 castings, each having a hole into which the boxes are dropped; the wings on the boxes engage in notches in these holes, which prevent them from

turning while being reamed. The reason 10 of these castings are used is that while only four reamers are working at once, a box is cooling between each pair in the meantime, the operator rotating the table only one-tenth of a turn at each drop; thus he is given time to remove a finished box and drop in a rough one, as the space immediately in front of him has no spindle.

Like the turning lathe, the reamer has a hydraulic feed and it is handled in much the same manner as the lathe; the feed is arrested by the stop shown in the center.

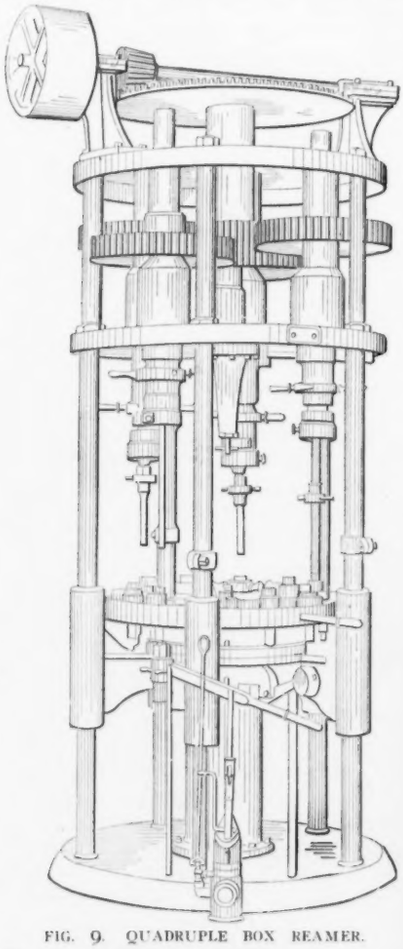

FIG. 9. QUADRUPLE BOX REAMER.

This machine has reamed 420 sets in 12 hours; 1800 sets, however, is an average week's work.

BOX TURNING AND FACING.

Three ordinary 14-inch commercial lathes operated by one man, turn the outside of the boxes, two tools being carried, one of which turns the taper from *F* to *G*, Fig. 8; the other finishes the part from *H* to *I*. While all the lathes seen were fitted with taper attachments, the taper on each was obtained by setting over the tailstock. The lathes are arranged to form three sides of a square, the operator changing the work without stopping the machine, using a leather pad for protection on the inside of his hand, the arbors being square on the large end and fitting loosely into a square driver. This man turns 1800 sets per week; 1200 boxes per day! This represents more than 120 per hour, as some little time is taken up in changing, grinding tools, etc. These boxes are about 6½ inches long 1¼ inches diameter on the small end and 2 inches on the large end.

The boring machine finishes the large end of the boxes, but the small end is finished in a lathe, the spindle of which carries a two-bladed end mill; about 4 inches to the right of this mill is a casting having a hole in it and in this hole the boxes fit loosely. On the carriage which is operated by a pilot wheel, is a center in line with the lathe spindle; this center, entering the large end of the box, forces it against the end mill which faces off the end until an adjustable stop prevents the carriage from traveling further.

The last precaution is the size of the box, a carefully tested reamer being run it to it on a single-spindle machine before it is allowed to go to the assembler.

A large percentage of the finished axles are bent to shape on a bulldozer, in which a suitable form is arranged; most of these are bent cold, but occasionally shapes are desired which require a bend so sharp that the axles are heated before being put in the machine.

The malleable iron nuts are first chucked in an ordinary turret lathe, where they are drilled, tapped, and faced, the operator reversing the machine to back the tap. The nuts then go to the facing machine where the outside end and the outside of the collar are faced.

German Electrically Driven Portable Drilling and Tappin Machine.

This machine is designed primarily for use in locomotive and similar works, and, as will be noticed, is a very convenient affair for performing operations on work which cannot readily be brought to a fixed machine.

The method of transporting this drill about the shop is obvious. For ordinary drilling the weight of the machine is sufficient to resist the pressure of the drill,

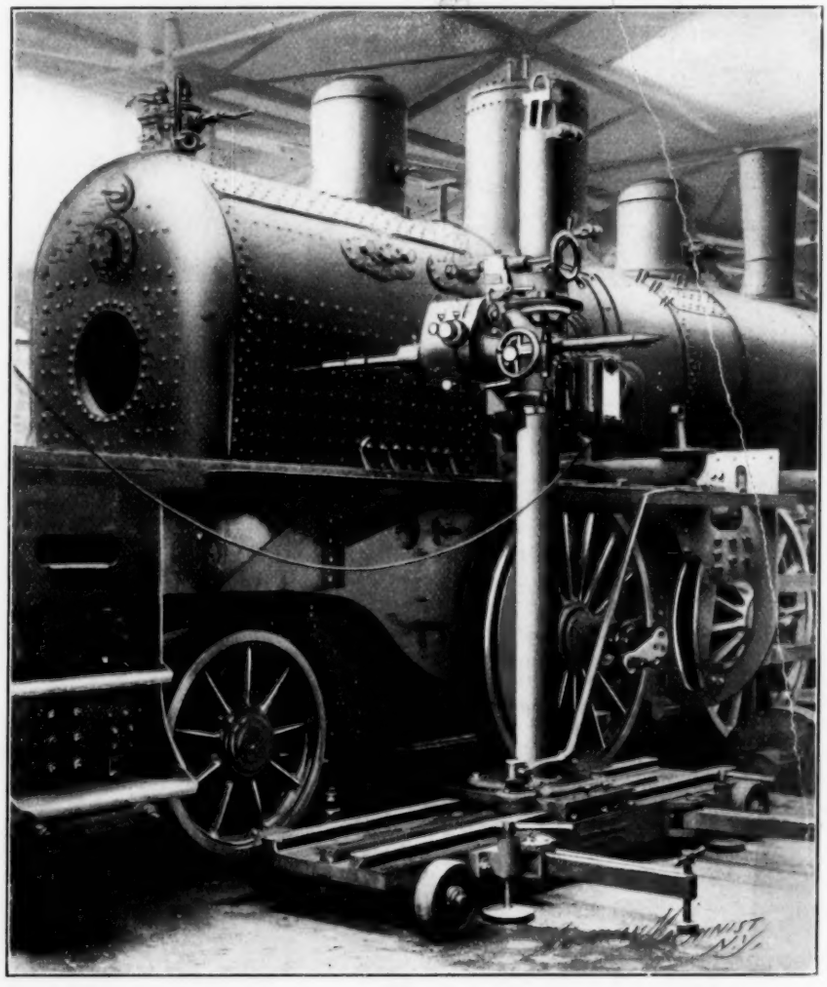

FIG. 1. GERMAN PORTABLE DRILLING AND TAPPING MACHINE.

and for larger work the affair is braced by the pivoted arms at the side of the platform. When brought to position the weight is taken and the carriage fixed by four screws fitted at their lower ends with large circular shoes.

The carriage itself has a length of 6½ feet and the upright has an adjustment along the platform by crank handle, rack

and pinion, of 58 inches. The base of the upright slides along dove-tailed ways, and the drilling-head may be adjusted vertically on the foot from a spindle center hight of 24 inches to an extreme hight of 82 inches.

The spindle is driven by a 2 horse-power motor, located at the side of the head and connected to the spindle by worm and spur gearing so arranged as to give two rates of speed to the drill. The drilling head may be rotated about the horizontal axis and swung completely around the upright.

The spindle is about 1¾ inches diameter, and has a feed movement of nearly

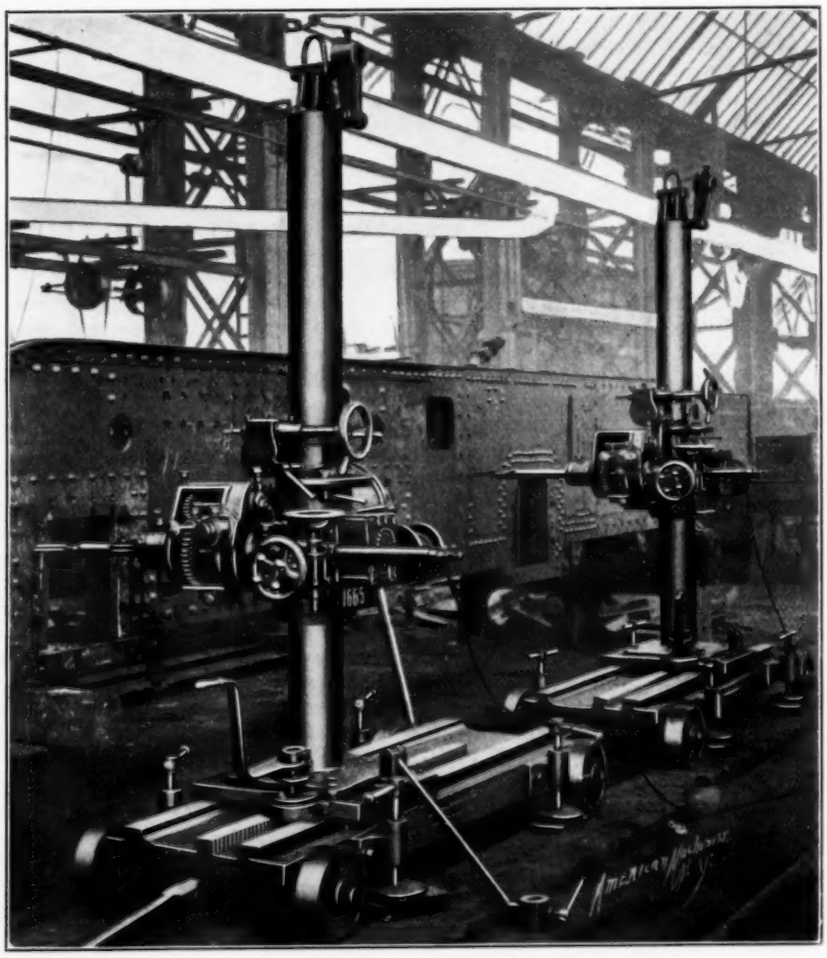

FIG. 2. GERMAN PORTABLE DRILLING AND TAPPING MACHINES.

18 inches. Holes may be drilled up to 2½ inches, or tapped 1⅜ inches, and, with bar and cutter, bored to 4¾ inches. The motor is arranged for reversing to facilitate tapping operations.

The makers of this machine are Collet & Engelhard, Ltd., Offenbach-Main, Germany.

At Yokosuka the Japanese have under construction a battleship with a displacement of 19,250 tons, which is a greater displacement than has been attempted by any other navy heretofore, and as soon as this vessel is launched a sister ship is to be laid down.—*The Engineer.*

Echoes from the Oil Country—An Insane Foundryman.

BY W. OSBORNE.

If a man wants to enjoy peace of mind in this world there are some things that he should avoid. In this day of microbes, intensified production, and the almighty dollar the chances of "catching something" always have to be considered, and as soon as one finds that he is "exposed" prompt measures should be taken. It is not then the time to inquire how it happened; that may come afterward if it is desired, but if the complaint becomes dangerous a man has no time left from tending to it to do much investigating, and if it is but a light attack and yields to treatment he usually forgets all about the matter.

Perhaps owning a foundry is not a disease, even if having to look after it is, but without doubt the figuring habit is. I cannot go into too many details, nor explain just how it happened that Jones had a foundry on his hands without having been brought up to the business. He had never served time as a molder before he tried to run things. Perhaps it was in some former state that the figuring microbe got into his system and had lain dormant until such time as conditions were ripe for it.

When a man tries to run a business in which he has not had training he should be very careful and study up all of the traditions, or the first thing he knows he will be trying something that could have been explained to him as being absurd. He may go on and try it and, not knowing anything as he should know it, the thing may be made to work, and that will interfere with time-honored traditions which should be treated with respect; and worse than that, it may make some respectable people in the business change some of their ways of doing things. New comers should be considerate of the feelings of others and not go to doing things that might be considered as a reflection on the intelligence of others.

Jones needed a man of practical experience to manage matters for him. He could get in the orders, buy the stock, and pay the bills, but that microbe was there.

Jones had several molders working for him, and he marked the jobs he gave them to do, and he *figured* that the one that lost the most castings was the poorest man. After making some practical observations in the matter, and some corrections of his estimates on account of difficult work he expressed his opinion to some of the men with the result that he found one who "won't work for a man who doesn't know the first thing about the business."

When this microbe gets acclimated in the system it is wonderful how it will multiply. It was not long until Jones actually wanted to know *in figures* how much iron he was melting to a pound of coke. The man who was engineer of the cupola could give him all the information that any sane man needed, and never, under any consideration, used an ounce more than was absolutely necessary. He knew for an absolute certainty that he was doing lots better than the other foundry in town, and if they were melting eight for one he was doing at least twelve and maybe better.

Jones actually went and put in scales and directed that everything be weighed, and not satisfied with that stood by to see that it was done. That was the last straw, Jones was let go unhindered on his rash way to destruction, and there was a new man running that cupola.

Think of the malignance of that demon of a microbe that said that whereas, formerly, he had melted between five and six to one he was now doing nine to one or better. Such work as that began to make trouble inside. If the wind was put on at the usual time the heat was over and the bottom dropped too soon, and if the wind was not put on until there was only enough time left in the day to get done at the usual time the

men could not make their jobs last. One man found it such hard work that he quit; the others did some other work to fill in the spare time.

This foundry did all sorts of work; grate bars, pulleys, engine parts, stuff for sawmills, lawn rollers, feed boxes, parts of stoves, bridge castings, washers, kettles, pots—anything that might be wanted in gray iron—and the usual, democratic price was two and a half cents a pound. Some castings were charged the enormous sum of three cents, but that was looked on as extortion by those having to pay it. Grate bars ruled at two and a quarter, with an occasional large order taking the still lower price of two cents. On very rare occasions, when an odd casting that required much cleaning and fitting up had to be used for a pattern, a charge was made for the time thus spent in addition to the price per pound for the casting.

That peace-destroying microbe that had taken possession of the upper story of Jones' anatomy compelled him to go around and get the time that it took to make the various cores, and the material that was used in them; it even had him estimating the cost of the fire that dried them and had him keeping the time of the molder for each piece or lot of similar pieces, and watching the material he used and the amount of help that he needed. And even then it would not release him but he had to give attention to the chipping and the cleaning, and the average chance of bad castings. I tell you what, it just made his life miserable, and on top of it all it made him believe that he could make some castings for less than two cents a pound and that others cost him fifteen.

In his delirium he even attempted to charge the prices that this little demon of figures told him about, with a reasonable profit added. The man who got the cheap castings did no grumbling, but when it got to the other end of the line Jones' madness was clearly recognized.

Except in rare cases where his would-be customer was also inoculated with the same microbe, or else was in such a fix that he had to get the work done promptly regardless of the cost, the high-priced castings went to the other foundry. In fact some of those who had quantities of high-grade work went to the other foundry even though their microbe told them that Jones' microbe spoke the truth as to the cost of castings.

Even though Jones believed in his figures he could see that there were cases where it was policy to use a little tact. It is one thing to tell some people that you will make a certain two-pound casting for ten cents each, and quite another thing to tell them that you will make them for five cents a pound, and Jones found it to his advantage to quote "by the piece" whenever he could do so.

Whatever else might be said of Jones it could not be denied that he made good castings. As his competitor put it "He has to make them good or he would never get any work at the prices he charges, unless it was some big job of coarse work, and he has killed those kinds of of jobs by cutting the life out of them." You can see the kind of trouble that figuring microbe got him into. On the one hand he was blamed because he charged too much for the small work. The customer blamed him in this case. On the other hand he was blamed because he did not charge enough for the large castings, and now it was those in the foundry business that were finding fault.

A not inconsiderable part of Jones' time is spent in trying to inoculate others with the same disease that he himself has in such a virulent form. If he persists he will surely make converts or else lose entirely his own reputation for sanity.

On an occasion he received some drawings and a letter asking him to quote prices on high-grade castings. The inquiry came from a large manufacturer who did not at that time have a foundry. Nothing was said as to the quantity of each that would be wanted, and the letter stated that only enough drawings had been sent to give an idea of the kind of castings that would be wanted, a drawing having been selected here and there so as to show the various classes.

Jones went over the drawings carefully and finally returned them with a letter giving his price *per casting* for each casting represented by a drawing, and informing them that if they would forward drawings of any other castings that might be wanted he would be glad to quote on them. He also informed them that the prices quoted were for single castings or small lots, but that if they were wanted in quantity he could give better prices.

He received a letter in reply that read something like this;

"Dear Sir—You seem to have misunderstood our recent letter to you in regard to castings. We would like to a price per pound for such castings as we may need, and the drawings were sent so that you might have the required knowledge of what they are. We cannot tell just which castings we may need, or how many of any one kind, but we can give you an order for a hundred or more tons at a time if you make the price right. We would send you patterns and statements as to how many to make from time to time, and will agree to call for not less than thirty tons a month. If everything is satisfactory we will be in position to give you another order before this one is completed so that you can do our work continuously.

"In view of the size of this order, and of the fact that we pay all bills for work done by the tenth of the month following its completion we feel that we should have your best prices, etc., etc."

As I have said, besides running a foundry Jones was interested in having others suffer from the same disease that was troubling him, and he answered that letter in his own way.

"Gentlemen—I have received a letter from you of even date which I think was written under a misapprehension, or else it was intended for someone else. If not, I have not been keeping up with the times. Please look the matter up and let me hear from you again; in the meantime I am thinking of putting in a stock of supplies such as mechanics need. I have to keep some stock now to accomodate my customers, and in going over the situation I have been wondering if it would not be a good thing for me to enlarge considerably on what I am doing. I have always heard your calipers, scales, milling cutters, gages, micrometers, cut gears, plumb bobs, etc., very well spoken of, and I think I could sell some of them. Kindly let me have your best cash price per ton for the same at your earliest convenience. If you make the price right I believe I can build up quite a good business in a short time, and if I am making castings for you it will serve to keep a more even balance, etc., etc."

It is said that this letter was referred to the head of the firm. He first read it with a frown. After finding out more about the former letters which had passed he began to rub his hands together and to chuckle to himself, and it is said that it finally became almost a classic with him.

Whether or not all this is true Jones made a lot of castings for the firm at so much a casting, but he still lacks the quotation he asked for. Contrary to expectations Jones is still in business. By one of those strange happenings that are beyond explanation the other shop was closed down in spite of the immense volume of business that flowed their way. Some people said it was the banks that did it; some blamed the sheriff; some claimed it was because the business got so big that they just couldn't handle it; but everyone agreed that in losing it they lost a gold mine, that is, everybody but a few cranks who were mad from the figuring microbe.

At the electrical show in Chicago there was a clock over seven feet high, of an ornamental design, every part of which was made of pins, there being altogether many thousands of common pins soldered together. Even the gear wheels, bearings, etc., are made of pins; there is no mainspring, the driving being done by a weight which is intermittently raised by electricity. The clock is said to keep good time and to be readily regulated.

The output of coal in the United States has doubled in the last 10 years. If the consumption continues to increase in the same ratio for the next 10 years, the required output will reach 600,000,000 tons in 1915.—*The Engineer.*

The Reproduction of Drawings of Great Length or Number.*

BY L. F. RONDINELLA.

PRINTING LONG PHOTOGRAPHS.

At the Centennial Exposition in 1876, the firm of F. Gutekunst & Co., of Philadelphia, exhibited a panoramic photograph of the exhibition buildings printed in one piece, 10 feet long by 17 inches wide. This is the largest photograph that had been made up to that time, and it excited a great deal of interest here and abroad. The panorama was taken on seven glass negatives each 18 inches wide by 22 inches long, so that the details pictured at the edge of one negative were repeated on the adjoining negative. The print was made by seven successive exposures in a frame large enough for one negative, and provided with light-tight boxes for holding the two ends of the sensitized paper rolled up while an intermediate section was being exposed—a form of apparatus that is still used by photographers in making long prints from several glass negatives. To secure evenness of tone at the edge that was to be printed again under the next negative, it was vignetted or blended with a strip of paper moved by hand—a process that must have required considerable skill, and has since been supplanted by an automatic vignetting screen on the front of the frame. To secure sharp definition in the double exposed parts, the negatives and paper were first marked with guide lines which were afterward made to coincide in arranging them in the printing frame. In a device of this kind the time consumed in arranging the glass negatives and paper is almost as great as that necessary for making the exposures, and good results can be obtained only with great care and skill.

With the modern panoramic camera and gelatin film negatives, photographs may now be made in one piece four or five feet long, and the ordinary printing frame with plate glass to hold a single negative of this size is not unduly expensive nor difficult to manage. But the reproduction of moving-picture films whose length is generally over 50 feet, and the making of blueprints, etc., from tracings of engineering drawings over seven feet long, is a much more difficult matter. Such prints can of course be made in sections, in an ordinary photographic printing frame and pasted together after development; the amount of time consumed in arranging the exposures and the danger to the negative or tracing are very great; the subsequent joining together takes much additional time, and is not always permanent; and in the case of blue-prints or paper negatives made thus from long tracings it is almost impossible to secure uniform color in the different sections, and continuity of lines where they join.

*Paper read before the Engineers' Club of Philadelphia.

THE USE OF ELECTRICITY FOR MAKING PRINTS

The possibility of making prints indoors with artificial light has been realized by employing the enclosed-arc lamp in several more or less practical ways that have made the drafting departments of large establishments independent of adverse conditions of light and temperature out-of-doors. One of the oldest of these arrangements uses the ordinary printing-frame, with a sheet-metal reflector-hood whose rectangular opening covers the plate-glass of the frame, and whose perpendicular cross-sections are parabolas with the enclosed arcs of the lamps approximately in their focal lines. Since the luminous effect varies inversely as the square of the distance from the light, it will be understood, e. g., that with the arc 10 inches from the glass the printing speed would be twice as great as with it 14 inches away, but in the latter case the illumination would be more uniform over a limited area. Therefore while this method of lighting is not unduly expensive for small prints, it requires a large number of lamps set close together to give even distribution over a big glass, and the first cost and running expense are then very high.

The use of a hollow glass cylinder, with flexible negatives and sensitive material held against its outer surface and illuminated by one or more electric lamps within, is quite an old foreign invention, and has been patented abroad and in the United States in many forms. The most practical method of applying it is to place the cylinder vertical and gradually to lower along its axis a single arc lamp of very high candle-power. The glass must be rolled accurately in two parts and supported in metal frames; and as the intensity of illumination on its surface is inversely as the square of the cylinder's radius, the latter is usually less than 15 inches, and the greatest possible width of print is therefore less than 4 feet. To insert the materials for printing, the top of the cylinder must be within reach of the operator, and the maximum length of print is therefore less than 7 feet. In common with large blue-print frames, the glass is easily broken by jar or sudden change of temperature, and the average half-cylinder costs about $50 to replace. For making short prints indoors, the glass-cylinder machine is a convenient but expensive apparatus.

MAKING LONG PRINTS BY SUNLIGHT.

For making long prints by sunlight, an old idea that appears to have been independently invented and employed by several parties consisted in using a large wooden cylinder mounted to revolve on a horizontal axle, with the sensitive paper and tracing stretched tightly around its periphery. The earliest record of its use that I find was made in May, 1887, when at the meeting of the American Society of Mechanical Engineers, a blue-print 3½ by 8 feet was exhibited by Professor Thurston, who stated that it had been made by Prof. E. C. Cleaves, of Sibley College, and that it was "probably the largest blue-print yet made by any process." This would now be considered a comparatively short print, yet the cylinder must have had a diameter of nearly 3 feet. In 1899, the Northern Pacific Railway was using a cylinder 6 feet in diameter for making prints up to 18 feet long, and another party whose name I have forgotten, had a cylinder 10 feet in diameter for making prints up to 30 feet long. The impossibility of exposing such large cylinders elsewhere than on a flat roof, and the difficulty of manipulating the materials, combine to make them impractical and uneconomical for general use.

This doubtless was the experience at Cornell University, for one year after he had described the machine above referred to, Professor Thurston exhibited a print 2½ by 14 feet made there on another apparatus which consisted essentially of a thin board slightly longer and wider than the proposed print, covered with felt, and with clamps at the sides and ends to hold materials smoothly stretched. The loaded board was sprung and (by means of cleats on another base-board) was held with its length in a flat arc, convex upward, and it was exposed in the open air and printed by sunlight. This device occupied less cubic space than a cylinder of equal capacity, and could be loaded and unloaded indoors, and while it was doubtless much lighter and less expensive than a printing-frame with plate glass of equal size, it must have been equally impossible to expose it on a bracket outside of a window, and it probably had to be used on a roof like the large cylinders above referred to.

In 1898, the desire to make some one-piece blue-prints from a very large tracing suggested to the writer the possibility of devising a compact machine in which the blue-print paper covered by the tracing might be kept in close contact while they were drawn at a regular speed under an exposure-opening, through which the light would strike successively upon all parts of the moving tracing, and thereby make the photo-print beneath it all in one piece. In the first experimental apparatus a dark box, 45 inches long by 25 inches wide by 6 inches deep, was used, with the top in two parts sliding in from each side to close or to form an opening of adjustable width. Inside were a series of rollers carrying a continuous broad apron of rubber cloth, so arranged that its upper surface was convex and traveled at a regular speed under the exposure-opening, when power was applied to turn one of the rollers. Above this convex surface and kept in close contact with it was a continuous cover-strip of tracing-cloth, that was drawn off of one roller against the tension of a friction-brake, and on to another roller that was revolved by gearing so that its circumference traveled at the same speed as the rubber apron. The rolls of

long tracing and blue-print paper were placed on carrier rods inside the box, and their free ends were fed in at one end of the convexed surface by starting the apron and cover, which held them firmly together. The lids were then adjusted to the proper exposure opening, the box was run out through a window on to a bracket in the sunlight, the mechanism was started, and as successive parts of the tracing traveled under the exposure opening, the print was made. When developed the print would show uniformity of color and sharp definition crosswise, but there was a slight blur in the lengthwise direction, due to the fact that as the transparent cover was wound on to the pulling-roller, its circumference and speed were slightly increased, and the tracing was pushed along a little faster than the blue-print paper beneath it. This defect could have been prevented by arranging the transparent cover like the rubber apron in a continuous band traveling over slightly larger rollers, but then there would have been a strip of lighter color across the print at each interval where the joint in the cover came in contact with the tracing, at that point, there being two thicknesses of material to print through. So this scheme was abandoned in 1899, but more than three years later a patent was granted to another Philadelphian for an application of the same ideas, with the differences (see Fig. 1), that both conveyors were long rolls of material instead of one being an endless apron, and the lower one was drawn with more or less friction over a "stationary curved bed" instead of over a series of rollers. A second patent granted a few months later to the same inventor, protects the use of "two endless-apron conveyors," and this principle is applied in the Franklin Blue-print Machine, which will be described later.

THE "STAR" COMBINED SUN AND ELECTRIC PRINTING MACHINE.

The next idea and the one which has resulted in the development of the Star Photo-Printing Machine, was to use a horizontal drum of sufficiently small diameter so that it and the materials to be printed, together with the necessary driving and regulating mechanism, could be carried inside of a dark-box or casing, whose dimensions would permit of its being exposed for sun-printing on a bracketed track passing through an ordinary window. In April, 1900, satisfactory prints of various sizes were made in an experimental apparatus containing a drum 12 inches in diameter by 40 inches long, and in October, 1900, application was filed for a patent which was issued March 19, 1901. Lack of time outside of regular professional and social duties has made its development rather slow, and has permitted two later inventors to make an earlier commercial introduction of their machines; but this is the only one now on the market which can be used for sun-printing under ordinary conditions, while for electric-printing it is the least expensive and most rapid for a moderate consumption of current. The construction and method of using the Star Photo-Printing Machine will be understood from a brief description, with the aid of two illustrations. The machine is made in three sizes for producing prints of any length up to 70 feet, with maximum widths of 30, 42 or 48 inches. A furniture-finished oak casing contains the materials before, during and after printing, and all of the mechanism, except the 1/20-h.p. electric motor and its reducing gears, which are carried outside of one end. This casing is provided with ball casters, and may be mounted on a track to be rolled out through an ordinary window facing south for sun-printing, or may be placed in a fully equipped support for electric printing by enclosed-arc lamps, or may be stood on a table with its attached equipment for electric-printing with mercury-vapor tubes. Its top is closed by a two-leaf lid (which may be swung open to rest in three different positions) and by an adjustable curved shutter, so that the exposure-opening can be varied from 0 to 105 degrees for sun-printing, and to 120 degrees for electric printing, permitting prints to be made by either kind of light with equal rapidity.

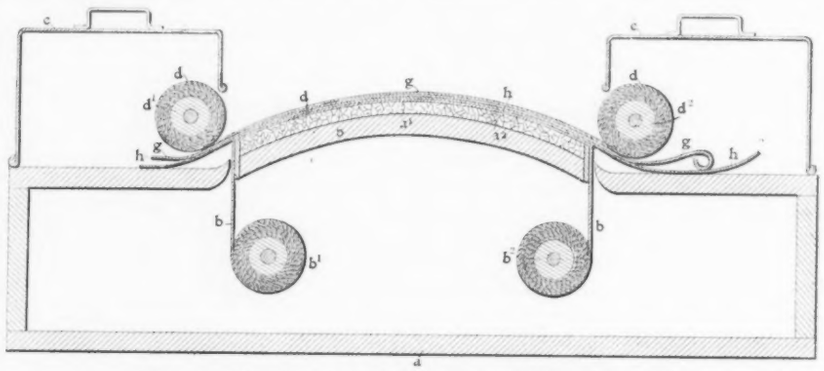

FIG. 1. CONTINUOUS PRINTING OVER A CURVED SURFACE.

A lock is provided to fasten the lid to the shutter so that a roll of sensitive paper or anything else placed inside of the casing, may not be meddled with. (See Fig. 2).

Under the exposure-opening is a felt-covered wooden drum, to which is permanently fastened the outer end of the transparent cover—a strip of best quality tracing cloth over 70 feet long, carefully prepared so that it will wind true off of its tension roller and on to the drum, or *vice versa*. Along one edge of this cover, numbers are stamped at every foot to indicate the maximum length of print that may yet be made when part of the cover has been wound around the drum. By carrying the cover-strip from its roll over another roller to the drum, an inclined feed-apron is formed down which the tracing and sensitive paper are carried into contact with the drum at the tangent-point *K* (Fig. 2), and up which they are discharged from *K* after printing, and fall into the receiving compartment in the near side of the casing. The tension of the transparent cover may readily be adjusted by slightly turning a wing-nut in a friction brake, so that close contact to the sensitive material is obtained with smooth or rumpled tracings, on thick cloth or thin paper, traveling at any desired printing-speed. The little electric motor that operates this machine is mounted on a bracket at one end of the casing and has its high speed reduced by a spur-gear-couple to a driving spindle, which passes through the casing and carries on its inner end the pinion *D*. By means of a spring latch, outside the casing, fitting into one of two grooves around this spindle, the latter turning always in *one* direction, is made to revolve the drum and the roll of transparent cover in *both* directions. When the spindle is drawn out, the pinion gears through a second reducing-couple *E* to the drum-wheel *F*, to move the drum and cover forward; and when the spindle is pushed in, the pinion gears through an idler *G* to the roller wheel *H*, to rewind the cover and turn the drum backward, against an adjustable friction at its bearings. The three different forward speeds are slower than the three different return speeds, and both are very regular. Their combination in double-printing gives nine different durations of exposure, and this number may be multiplied by changing an incandescent lamp-resistance at the top of the motor, without the use of an external rheostat or cone-pulleys, that are employed in other machines.

The support for the Star Photo-Printing Machine is made of oak finished like the casing with angle-iron braces, and occupies a floor-space of 3 feet by 4, 5, or 5½ feet. It is wired so that the binding posts at its top can be connected at once to the mains of a two- or three-wire system carrying 110 or 220 volts direct current. Enclosed-arc lamps and motor having the same external shapes and dimensions are furnished for either voltage. Each lamp is less than 23 inches high, weighs less than 11 pounds, and has a current consumption of 715 watts; and four lamps are used with the No. 30 machine, five with the No. 42, and six with the No. 48, placed 9 inches between centers. The motor consumes about 40 watts. The lamp is a new type, having very simple

construction, with only two moving parts; it at once establishes and maintains a very steady arc of high actinic power, lasting for about 130 hours continuous burning with one set of carbons. The lamps and reflector are fastened to a suspension-beam which is carried by ropes anchored to the top of the support and passing over double pulleys, so that only half of the total weight is borne by the operator in raising or lowering the loaded beam. The reflector hood is hung from the beam by two chains, so that it can be dropped by hooking down one or more links when the consumption of the carbons brings the arcs appreciably below its focal line.

A Cooper-Hewitt outfit of three mercury-vapor tubes can be furnished for the No. 42 machine, which will give an equal printing speed with about one-third of the current consumption, so that the greater first cost is soon saved in the reduced expense of operation.

With the machine in its support for electric printing with arc-lamps, the shutter and lids are thrown open; the suspension-beam is lowered so that the reflector-hood covers the upper third of the drum's periphery, and the lamps are close to the exposure surface; the switch on the end of the support is thrown in, lighting all the lamps at once, or those not previously cut out by their individual switches; the spindle is drawn out to gear with the large wheel *E* (see Fig. 2) and the motor is started by throwing its switch to the point that will give the desired forward speed to the drum and its transparent cover; the tracing or negative and sensitive paper are placed face downward on the feed-apron, and are drawn in at *K* between the drum and transparent cover, and the latter holds them in close contact with the drum while they travel around under the reflector-hood; the forward exposure thus continues automatically until the last part of the tracing or negative appears from under the hood; the motor is then stopped while the spindle is pushed in to gear with wheel *G;* the motor is started again, and rewinds the transparent cover tightly around its roller, thereby turning the drum backward with the tracing and sensitive paper still in close contact under the light, completing the exposure and discharging the tracing and print at *K*. The machine is thus restored to its original condition.

When making a single long print, the roll of sensitive paper is slipped endwise over its aluminum carrier-rod, which is then inserted into its hole-and-slot bearings at the two ends of the casing; the motor is run for a moment while the free end of the sensitive paper is fed in at *K* and held by the transparent cover; the long tracing in a roll is then slipped over *its* carrier, and inserted in its bearings; the motor is started, the free end of the tracing is fed in, and the double exposure is made as described above. As the tracing and print feed out of this machine, they drop from the feed-apron into the receiving-compartment of the casing; or while the tracing is thus cared for, the print may be rolled up by hand ready for development. When making prints from several tracings the roll of sensitive paper may be used as described above, and the tracings fed in side by side, or one after another, until all have passed under the cover. The exposed paper is then cut from the roll, and fed out with the tracings in reverse order while the printing is being completed.

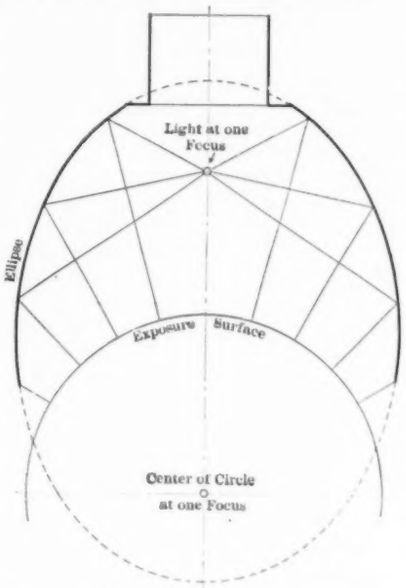

FIG. 3. VERTICAL SECTION OF RONDINELLA'S ELLIPTIC REFLECTOR FOR UNIFORM DISTRIBUTION OF ELECTRIC LIGHT UPON A CIRCULAR CYLINDRICAL SURFACE.

THE ELLIPTIC REFLECTOR.

The best light from enclosed-arcs for electric printing is obtained by placing the lamps directly above the axis of the drum, for the strongest rays are thrown downward from the upper carbon, and the intensity of illumination diminishes rapidly above an angle of 40 degrees to the horizontal. These strongest rays then strike directly on the exposure arc of the drum, and by enclosing the lamps under a reflector-hood, especially designed for the Star machine, the weaker rays are also caught and reflected directly upon the printing surface, so that *all* of the light is utilized. The superior efficiency of this form of reflector-hood (see Fig. 3) depends upon an original application of two mathematical principles of the ellipse, for the invention of which I first put myself on record before the

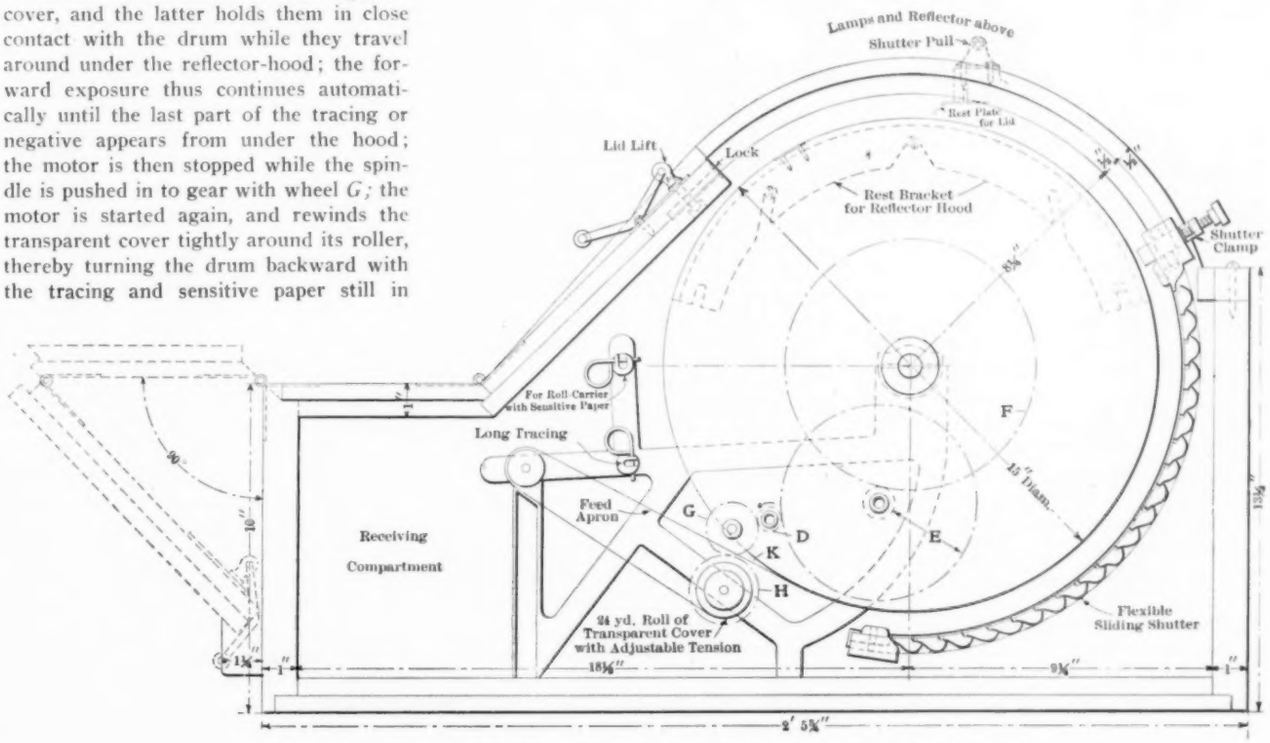

FIG. 2. END VIEW OF THE MECHANISM OF THE STAR PHOTO-PRINTING MACHINE.

Franklin Institute at its meeting of December 21, 1904. It is well known to mathematicians, first, that a tangent to an ellipse makes equal angles with the two focal radii from the point of contact; and second, that the added lengths of all pairs of focal radii are equal. By using a reflector whose cross-section is an elliptic curve, and placing the electric arc at one focus, all the rays of light that strike on its inner surface will be reflected to the other focus, and they will all have the same total length. If an equal length be subtracted from every reflected ray by interposing a curved surface whose cross-section is a circular arc with its center at the second focus of the ellipse, then the reflected rays of light will be all normal to the circular curved surface, and will be all of equal length and equal illuminating intensity. The elliptic reflector used with the Star Photo-Printing Machine produces this effect by having the lamps hooked in a fixed position to the suspension beam, from which the enclosing reflector-hood is suspended by two adjustable chains, as described above, so that by means of peep-holes in its curved surface its focal line can be made exactly to coincide with all the electric arcs; and when the beam is lowered until the ends of the reflector touch the rest-brackets at the ends of the machine-casing, the focal line of the reflector is at the proper distance from the axis of the drum, so that the latter would coincide with the second focal line of the complete ellipse. The distribution of the direct and reflected light on the curved exposure surface in the Star Photo-Printing Machine is so nearly uniform, that it is possible to make small prints under its reflector with the drum stationary.

THE FRANKLIN BLUE-PRINTING MACHINE.

The writer naturally thinks his own machine is the best, on account of its earlier inception, its lower cost, its smaller size, and its greater efficiency; but this paper would be incomplete without at least a brief description of the two other continuous-printing machines that are now on the market. The Franklin Automatic, Continuous Feed, Electric Blue-Printing Machine* consists essentially of two strips of transparent celluloid overlapped and cemented at their ends to form endless bands, each mounted on two rollers that are geared to travel at the same speed. The two near sides of these transparent bands are kept in contact by being pressed down on to a fixed convexed surface which is located between the two runs of the lower band, with its chord inclined at about 60 degrees to the horizontal. Near and parallel to the outer run of the upper band is a sheet of plate glass to protect the inflammable celluloid from the heat of the arc-lamps. Motive power is furnished by a 1/10 or 1/6-h.p. electric motor mounted at one end of the framework, belted to a counter-shaft which carries a large cone-pulley, from which a second belt runs to a second cone-pulley on the driving-shaft, and this through a worm and reducing-wheels actuates the rollers that carry the transparent bands. The speed of travel of the bands is therefore varied by shifting the belt on the pair of cone pulleys. At one side of the machine a horizontal feed-table is provided, and a perpendicular screen to prevent the diffused light of the lamps from shining in the operator's eyes, and from spoiling the sensitive paper. At the other side, on the floor, is a dark-box into which the tracings and prints drop after exposure, and an iron framework which carries the enclosed-arc lamps (placed 7 inches between centers) and a reflector, with wiring, switches, etc. In making a print, the tracing and sensitive paper (face upward) are drawn from the feed-table between the contact-surfaces of the two bands, over the fixed convexed surface and discharged into the box on the other side of the machine; and during this passage most of the light from the lamps passes through the glass, and the two runs of the upper celluloid band, and the print is made. This machine occupies a floor space 5 feet wide by 5 or 5½ feet long, with additional space necessary for the operator at both sides and one end.

*Illustrated in the AMERICAN MACHINIST, p. 1782. Vol. 26 (1903).

THE FEDERAL BLUE-PRINTING MACHINE.

The Federal Blue-Printing Machine* consists essentially of a wooden drum about 30 inches in diameter, carried in roller bearings and revolved by the frictional pull of a transparent cover that encircles one-half of its periphery. This transparent cover is a 24-yard roll of tracing-cloth wound upon a let-off wheel which is provided with a friction brake, and the cover is threaded around the drum, through two pulling-rolls, and on to a

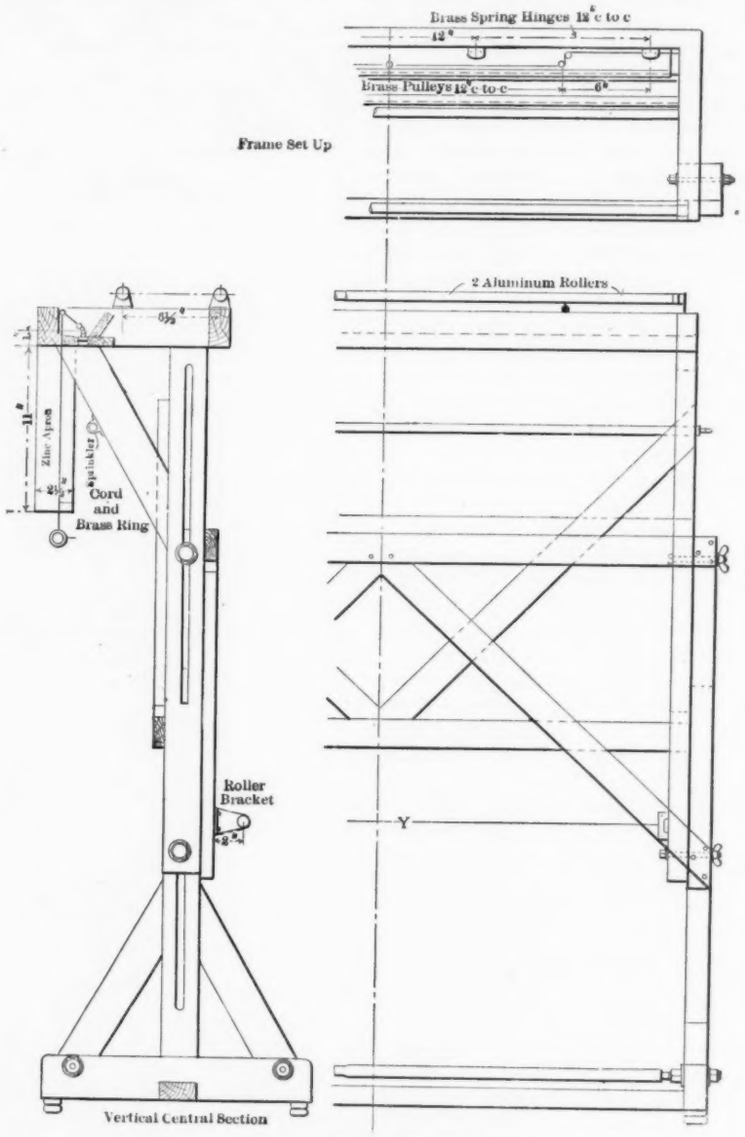

FIG. 4. WASHING FRAME FOR LONG PRINTS.

*Illustrated in the AMERICAN MACHINIST, p. 874. Vol. 25 (1902).

take-up roll, against which several friction wheels press. Motive power is supplied by a ¼-h.p. electric motor belted to a clutch-pulley with a speed regulator, and from there is transmitted to the pulling-rolls through a worm couple, a bevel couple, and a spur couple of gear wheels, on three non-parallel shafts. On the feed side of the machine is a rest-shelf to carry the sensitive paper and tracings, and at the bottom a receiving compartment for the tracings and prints after exposure. On the opposite side of the machine the enclosed-arc lamps (placed 7 inches between centers) in a plane-sided reflector, are carried on brackets fastened to the framework in such a position that the light is horizontally opposite the drum shaft, and the vertical opening of the reflector encloses about 90 degrees of the drum's circumference. In making a print the sensitive paper and tracing are held face outward against the drum, and pushed up until their ends are caught between the drum and the transparent cover; after which, in traveling automatically half around the drum they are exposed to the arc lights, and finally drop into the receiving box. When the entire length of the transparent cover has been run through the machine, it must all be re-wound on to the let-off roll before further printing can be done. This machine occupies a floor space 4 feet wide by 4¾, 5¾, or 6¾ feet long, and is over 5 feet high.

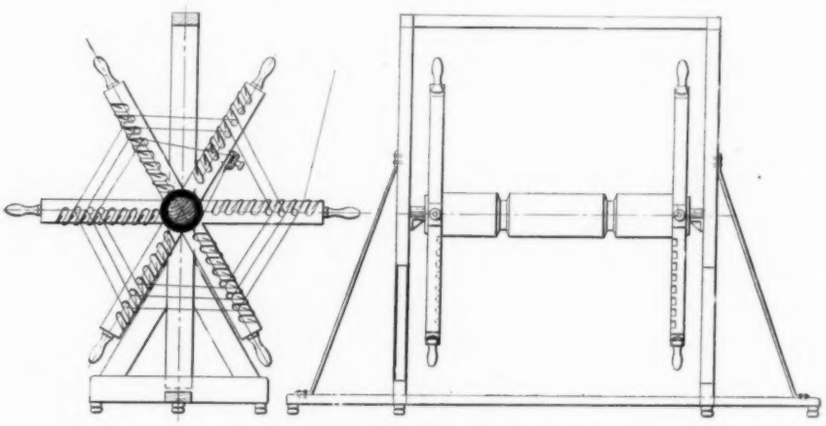

FIG. 5. DRYING REEL FOR LONG PRINTS.

ARRANGEMENTS FOR WASHING AND DRYING THE PRINTS.

Where there is a large wash-tank, a long print can readily be developed by folding it back and forth while it is pushed under the water or solution, and it can be dried by hanging it in the same way from a series of parallel wires or cords of moderate length, great care being taken to prevent its tearing while wet. For developing long prints in a narrow tank, and for drying them in a small space, the writer has designed a washing-frame and drying reel that one person can operate. The washing-frame (Fig. 4) is made of ash, finished with spar-varnish, and the metal parts are of brass, aluminum and zinc, so that water will not injure it. The bottom of this frame is immersed in the water in the tank, which need be only 2 feet wide by 3½, 4½ or 5 feet long. The upper part is made to slide up and down in the lower support nearly 2 feet, so that the top may be on a higher level than the head of the operator. The exposed print is wound on a roller, which is then placed in bracket-bearings on the lower frame. The hinged strip carrying one of the two rubber wipers at the top of the frame is then drawn up, and a metallic fastener strip (attached by tapes to the shaft of the drying reel) is passed over two aluminum rollers at the very top of the frame, through the wiper opening down under two more aluminum rollers immersed in the water, and up to the rest on the front edge of the tank. There the free end of the exposed print is attached to the fastener-strip by spring-clips arranged so as to prevent tearing, and is laid in the bottom of the tank; and (through a rubber hose attached to a faucet) water is turned to a sprinkler-tube that passes back of the framework below the top. Then by winding the drying reel, the tapes, with the fastener-strip and the attached blue-print are drawn back through the water in the tank, and up back of the sprinkler which thoroughly washes the print. When the fastener-strip has passed through the wiper opening, the spring-hinged wiper-strip is released, and the two rubbers, pressing on opposite sides of the washed print as it is drawn through, wipe off the loose water as effectively as a pair of wringer-rolls.

The drying reel (Fig. 5) is capable of carrying 80 feet of material, and consists essentially of a rectangular framework 5 feet high by 3½, 4½ or 5 feet long, suitably braced, and carrying on the inside of its uprights two bracket-bearings with hinged caps, so that they may be tightened with more or less friction around the journals of the reel proper. The latter has a large wooden shaft with three or more grooves in which are wound the tapes attached to the metallic fastener-strip already referred to; and it carries at each end a six-armed spider with a winding-handle at the end of each arm. In the inner face of the arms circular holes are provided in one spider, and slots with springs in the other; and into these, aluminum tubes are inserted as the reel is slowly turned, and the developed print is drawn from the top of the washing frame around the tubes in the form of a six-chord spiral. The *back* of the print is kept in contact with the tubes to prevent a slight chemical discoloration which would otherwise result, and a little slack is allowed in the winding to allow for contraction as the print dries. Although it takes but a short time for the wiped print to dry, the loaded reel can be lifted from its bearings and an empty one substituted for immediate use if desired.

While the old-style glass printing-frames are perhaps sufficient for those having only a few drawings of small size to reproduce, a machine that will rapidly make good prints of any size in the open air when the weather is warm and the sunlight steady, or indoors by day or night when the outside conditions are unfavorable, will prove a very economical addition to the photo-printing equipment of a large and progressive establishment.

DISCUSSION.

L. F. RONDINELLA (answering a question)—The speed of electric printing in this machine is about equal to that of clear sunlight through the plate-glass of a large printing frame. For example, the sensitive paper that we have here requires a total exposure of about 80 seconds to make prints either way with the dark-blue color that you see; and with a more sensitive solution I have made equally good blue-prints on this machine with 60 seconds' exposure to electric light or 50 seconds' exposure to sunlight. The unique feature of the machine is its ability to make very long prints in one piece, and it is of course true that for making a single small print a machine is not so advantageous as a blue-print frame; but in a printing-room, where it is necessary to make a large number of small prints, the tracings can be fed into the machine one after another on a long roll of blue-print paper, and in that way a great deal of time is saved.

CARL HERING—A somewhat similar apparatus could be made by simply using a Cooper-Hewitt tube, and slowly drawing the tracing and blue-print paper together over the tube, using the tube as a drum. The paper would then be within about ½ inch of the light itself.

MR. RONDINELLA—It might be possible to mount a Cooper-Hewitt tube in that way, so that the tracing and blue-print paper could be carried over as described, but I fear it would not work very well, for it would be difficult to get a good contact.

WM. MCCLELLAN—The Cooper-Hewitt tubes might burn the paper.

MR. RONDINELLA—I think they would

at least melt the paraffin in the tracing if brought as close as Mr. Hering suggests. Of course, there is comparatively little heat from the Cooper-Hewitt lamp, but when you put your hand on it you find that it is pretty hot, and if you kept a tracing against it long enough to print, I think there would be trouble. The Cooper-Hewitt outfit that we furnish with my 42-inch machine is a very compact arrangement where the three or four tubes are each in its little elliptic reflector, in a framework which carries the necessary resistance coils on top, and is lowered over the drum to a rest position where the axes of the tubes are two inches from the printing surface.

THE PRESIDENT — Is there any danger when turning the drum back, of the tracing or the paper slipping and making a secondary exposure?

MR. RONDINELLA—We have never had that experience. I do not see how it could occur, because they are pressed close together by the transparent cover which is fastened to the drum and completely encircles it. In the other drum machine which I spoke of, I think slippage is possible, although I have seen very good prints made on it.

F. G. THORN—When the print returns the second time past the light, is it removed from the machine or can it be run through again without displacement?

MR. RONDINELLA—Repeating the complete exposure is an experiment that I have not tried, for it is possible to use a speed slow enough to print even through a paper-negative with one forward-and-return run. I think, however, that a short tracing could be run through again if it were desired to do so; but I am afraid that with a long tracing, on account of the skewy character of the tracing-cloth, it would probably run in a little differently the second time, and possibly blur the print. If several small drawings are made on absolutely different materials, the tracing cloth and bond paper, for instance, you cannot get anything like uniform results when printing them together in any apparatus; but if all are made on tracing cloth, there might be perhaps a little darker shade in one than in another, but they could all be good prints.

MR. THORN—If you take several pieces of linen, even off the same roll, handled by different draftsmen, perhaps one will be on the board two hours, another on the board a week; there is also a difference in the draftsmen; one may have a little more moisture in his hand, and the tracings will be a little more opaque. Or one of the tracings may have been in its drawer two years, and the operator has to judge by the linen or paper whether it will give quick results or not, whereas if the operator could examine each print by turning it back, I think he would get much better results.

MR. RONDINELLA—It takes more experience on the part of a photo-printer to see the ultimate color from an undeveloped print than it does to foretell the relative translucence of several negatives or tracings. So if he is familiar with the sensitiveness of his paper, he can judge how long to expose each different negative or tracing. With a *new* lot of paper, when making a print from one tracing in a frame with hinged back he might determine the necessary exposure by bringing in the frame, and examining one end of the print. But when printing from several tracings at one time, it is impossible to do that, in a frame or in any other apparatus, without misplacing some of the tracings and spoiling the print. The usual and best way to determine the sensitiveness of new paper is expose a small scrap of it under a tracing in the printing apparatus for a measured length of time, and the character of the developed scrap will show whether a longer or shorter time is necessary for the prints made subsequently.

MR. MCCLELLAN—How are those long prints dried?

MR. RONDINELLA—The long print on the wall, which is three feet wide, was washed in the washing-frame and dried on the reel described in the paper, and the compactness of the apparatus may be judged from the fact that the printing was done by sunlight on a bracketed track outside of, and was washed and dried inside of, a closet measuring 4½ by 9 feet. The long narrow print was washed by hand in a tank by folding it back and forth in the water, from which it was removed when folded, and then straightened out as each fold was fastened to spring-clips on a drying wire. Of course, the wet print must be wound on the reel or hung from the wire with a little slack to allow for contraction in drying.

W. F. BALLINGER—Would it pay to install this apparatus, say in an architect's office where blue-printing costs from $50 to $60 per month? Can the blue-print paper be bought already sensitized or can the operator sensitize it?

MR. RONDINELLA—The paper can be bought already sensitized in rolls of ten or fifty yards, which may be carried and kept in the machine; not only for making blue-prints, but for making paper negatives with translucent lines on an opaque background, and positive prints with blue or dark-brown lines on a white background. As to whether the expense of the machine would be warranted in an office whose blue-print bills amount to $50 or $60 a month, I think I can answer without quoting figures, by saying that the cost of the machine would be saved probably in nine months if a boy was already employed who could run the machine; while if it were necessary to employ a boy especially for the purpose of operating the machine, it might take a year to save the cost. Of course, it would not be necessary to pay very high wages to a boy who could operate it, as it requires but little skill.

MR. HERING—What is the cost of current per hour for the apparatus, at the usual city prices?

MR. RONDINELLA—For operating this machine on either 110- or 220-volt circuits each lamp requires 715 watts per hour; and, figuring the cost of the current at 10 cents a kilowatt hour, the expense would be about 7 cents a lamp, or less than 30 cents for four lamps per hour, running continuously. With this machine only, that expense may be avoided by using sunlight when it is strong and clear; but when it is weak or variable, the time saved by electric printing and the more uniform results will compensate for the cost of current.

EUGENE D. HAYS—In relation to the amount of heat given out by the Cooper-Hewitt tubes, I wish to say that we place them 1¾ inches away from the film of a photographic negative without damaging the negative in any way. That is, 1¾ inches in an enclosed frame. Consequently, in a blue-print frame, with a little ventilation, we would be able to get at least that close, and that will give us very rapid results. I have been able to secure a very satisfactory print in 20 seconds, printing through glass only, on paper which takes 1¼ minutes on the Franklin blue-printing machine for the same result.

[Illustrations and descriptions of other apparatus for this purpose can be found in the AMERICAN MACHINIST as follows:

Pittsburg B. P. Co.'s Machine, p. 1218, Vol. 23 (1900); p. 601, Vol. 24 (1901); p. 423, Vol. 25 (1902).

Paper by S. L. G. Knox (A. S. M. E.), p. 642, Vol. 24 (1901).

Dietzgen machine, p. 1661, Vol. 25.

Combination daylight and electric machine, p. 224, part I, Vol. 27 (1904).

Johnson-Prentice machine, p. 235, part I, Vol. 27.—ED.]

The Largest Steel Ingot.

At the Manchester works, Openshaw, of Sir W. G. Armstrong, Whitworth & Co., Ltd., the largest steel ingot that has ever been made was cast recently. It weighed not less than 120 tons and was cast by the Whitworth system of fluid pressure, the 120 tons of molten steel being poured out from the melting furnaces into a steel ingot-mold weighing 180 tons. The whole was then pushed under a hydraulic press having a ram six feet in diameter, with a working pressure of three tons per square inch, capable of exerting a total pressure of 12,000 tons, and the ingot in a molten condition was subjected to this pressure, the result being to make it homogeneous and sound throughout. The ingot is intended for the huge low-pressure rotors for the 70,000-h.p. Cunard turbine liners.

A rusted and waxed iron pattern will draw better, other things being equal, than a brass pattern.

Rational Methods of Gas-Engine Powering.

SANFORD A. MOSS.

By "gas-engine powering" is meant the selection of the speed and cylinder dimensions of a gas engine to develop a given amount of power with a given fuel. By "gas engine" is to be understood internal combustion engine, which includes gasolene or oil engines, as well as engines operated with actual gas. General principles are given which will enable approximate results to be obtained without experience. Rational formulas are given which will enable exact results to be obtained if actual coefficients, etc., are known from previous experience. Only four-cycle stationary engines are considered.

ROTATIVE SPEED.

The first matter to be decided is the rotative speed. The selection of this is largely a matter of caprice, although a general rational rule can be given. The greater the speed the smaller an engine for a given power; hence the greatest possible safe speed must be selected. The considerations which limit speed are, first, rapidity of wear of rubbing surfaces, and, second, vibration and pounding. It is probable that the latter are the most important. It can be shown that engines are alike so far as vibration and pounding are concerned if the rotative speed is such that the "initial inertia pressure" is the same. "Initial inertia pressure" is the average of the two values at the ends of the stroke of the pressure in pounds per square inch of piston corresponding to the inertia of the reciprocating parts.

If I represents this pressure, it can be shown that

$$I = .00001421\ w\, l\, N^2$$

where w is the weight of reciprocating parts per square inch of piston, l is the length of stroke in inches, and N is the number of revolutions per minute. If we know the proper value of I from previously built engines, we may select the rotative speed of a new engine from the relation

$$N = \frac{265}{\sqrt{l}}\sqrt{\frac{I}{w}}$$

w is about 1.7 for the usual type of single-acting, trunk piston gas engines.* For gas engines of usual proportions and character, a safe value for I is 15.4 pounds per square inch. Inserting these values, we obtain as a value for the number of revolutions per minute, N, which will give proper conditions as regards vibration,

$$N = \frac{800}{\sqrt{l}}$$

where l is the length of stroke in inches.

This rational rule will be found to coincide well with modern practice. Of course, circumstances may occur which will make much greater or less speeds desirable. However, the rule gives a safe general guide. The constant can be varied to suit special circumstances.

Often the speed is decided by empirically fixing upon the "piston speed." This is the average speed of the piston in feet per minute, counting all strokes. If N is the revolutions per minute and l the length of stroke in inches, the piston speed is $\frac{N}{16}$.

A piston speed of 600 feet per minute is found to give good results in average cases. For small engines, this gives unduly high rotative speeds, however, and lower values are used, down to 400 feet per minute. On the other hand, 600 feet per minute gives unduly low rotative speeds for large engines and higher values are used, up to 800 or even 1,000 feet per minute.

Compression Pressure, Lbs. per Sq. In. Gage.	Probable Clearance as % of Displaced Volume.	Mean Effective Pressures, Lbs. per Sq. In. — Approximate Brake Horse-Power of Engine.						
		5 or Less.	10	25	50	100	200	500
50	40	60	65	70	75			
60	35	65	70	75	80			
70	30	70	75	80	85	85	90	95
80	28	70	75	85	90	90	95	100
90	26			90	95	95	100	105
100	24			95	95	100	100	110
110	22			95	95	100	100	110
120	20					100	100	110

Four-stroke cycle engines, at full power, using average natural gas or manufactured illuminating gas (87 B.t.u. per cubic foot of perfect mixture). For gases with other values, multiply by factors similar to those of Table 5.

TABLE I. VALUES OF MEAN EFFECTIVE PRESSURE FOR GAS ENGINES.

The rational rules above given, on the basis of a value of 15.4 pounds per square inch for the "initial inertia pressure," can be shown to give for the piston speed,

$$133\sqrt{l}$$

where l is the length of stroke in inches.

This rational rule will be found to coincide very closely with the empirical values above given.

RATIO OF LENGTH TO DIAMETER OF CYLINDER.

Attempts have been made to develop a rational criterion for the ratio of stroke to cylinder diameter for the usual type of gas engine, based on considerations of average amount of surface exposed to cooling, etc. These have not been very conclusive, however, and we must look to average current practice for guidance in this matter. It will be found that the stroke is about 1.5 times the cylinder diameter for usual cases, the ratio becoming 1.00 or 2.00 under special circumstances.

MEAN EFFECTIVE PRESSURE FOR AVERAGE FUEL.

The power produced by a gas engine is well known to be proportional to the average pressure in the cylinder, and the volume swept by the piston in unit time. The value of the average pressure during the compression and explosion strokes is called the "mean effective pressure," often abbreviated to M. E. P. This is the pressure given by the mean height of the indicator card. The M. E. P., the number of explosions per minute, and the length and diameter of cylinder give the power developed, as shown by the formulas given later.

The M. E. P. is theoretically independent of the size of cylinder, and depends only on the compression pressure and kind of fuel. However, the larger the cylinder, the less the cooling surface per cubic foot of cylinder volume, and therefore the less the reduction of pressure by cooling from the water-jacket, hence the M. E. P. increases with size of engine.

Theoretically, the M. E. P. increases with the compression pressure. However, various complexities enter into the actual case, so that a limit is reached, after which increase of compression gives little or no increase of M. E. P.

No rational procedure has ever been developed for taking all of these matters into account, hence we must predict M. E. P. empirically. Table 1 gives the result of my conclusions of average modern practice, as the result of examination of a large number of engine tests. As stated, the table applies to the case of average natural gas or manufactured illuminating gas. Means of deriving values for other fuels will be given later. Values are given for various compression pressures. Means for selecting compression pressure for any given case will be given later.

Of course conditions vary greatly, so that Table 1 can only be considered as a rough guide. A much more reliable table can be constructed by a builder for any single type of engine.

If the cylinder contents at the beginning of compression are highly heated by hot cylinder walls, etc., or by mixture with unexhausted products of previous combustion, or if they are greatly diluted with air, the mean effective pressure will be less than the values of Table 1, which gives values for average design. If the design is worse or better than the average, the values will vary accordingly.

SELECTION OF COMPRESSION PRESSURE.

Up to the point where the losses due to increased compression balance the gains, the higher the compression the better the result. However, there is often another limit to the desirable value of compression, "pre-ignition." If the temperature at the end of admission is high, the increase of temperature due to compression will heat the gases beyond their ignition point, and they will explode before the end of the compression stroke. This may cause considerable loss.

The ignition temperature of the various gas-engine fuels varies, that of gasolene being lowest. Then come kerosene, crude oil, illuminating gas, and blast-furnace gas, in the order given.

*See "Gas Engine Design Constants and Formulas," AMERICAN MACHINIST. Vol. 27, p. 482.

In order to prevent pre-ignition, either the admission temperature or the compression pressure must be kept down. If the combustion chamber and exhaust valve are well jacketed, the admission temperature will usually be kept low enough to permit of any compression pressure desirable from other reasons, without pre-ignition. An exception must, however, be made in case of kerosene oil or crude oil. These must be initially heated in order to vaporize them, and this causes pre-ignition to occur at lower compression pressures than are otherwise desirable.

As stated, if the combustion chamber is sufficiently jacketed, we may select the compression pressure from other considerations without fear of pre-ignition. However, in many cases there is not sufficient jacketing, and then the matter of pre-ignition limits the compression pressure. For average jacketing, a gasolene engine can carry a compression pressure of only 60 pounds per square inch gage; an illuminating gas engine of only 70, and a natural gas engine of 90 pounds per square inch gage. Engines with less than average jacketing must have less compression to avoid pre-ignition, and well-jacketed engines may have greater values.

On some engines a piece of uncooled metal of some kind projects into the combustion chamber. This is frequently the case with the point of an electric igniter. A rib may also be placed where the jacket cannot keep it cool. Such a piece of metal retains heat enough to cause pre-ignition with very low compression pressures. The remedy is to avoid ribs, sharp corners, etc., in the combustion chamber, and to keep the igniter points near and well connected to a thoroughly jacketed surface, so that heat is conducted from them readily.

The above general considerations will give a rough guide for selection of compression pressure. Table 1 also gives the clearance percentage necessary to produce a given compression pressure. The values are empirical and are conclusions from examination of many tests.

EFFECT OF FUEL ON POWER.

The values of mean effective pressure in Table 1 are for average natural gas or manufactured illuminating gas. We will now discuss the derivation of values for other fuels. The value of a gas for engine purposes depends upon the pressure which results after explosion. This depends directly upon the products in the clearance space after exhaust, the specific heat of the gas, the heat of combustion and the rate at which heat is lost to the jacket while inflammation is occurring. The rate at which heat is lost and the clearance products are probably the same for different gases in the same cylinder, and depend almost wholly upon the form of the cylinder and the total amount of heat generated. The "volumetric specific heat" or the heat which raises a cubic

Gas.	Formula.	Molecular Weight.	Density in grams per liter 0°C, 760 mm., 45° N. lat. at sea level.	Density in lbs. per cu. ft. at 32° F. 14.697 lbs. per sq. in.	Density in lbs. per cu. ft. at 60° F. and 14.7 lbs. per sq. in.	Specific volume, cu. ft. per lb., 60° F. and 14.7 lbs. per sq. in.	Higher value, heat of combustion, B.t.u. per lb. 32° F. before and after combustion. Water condensed.	Lower value, heat of combustion, B.t.u. per lb. 212° F. before and after combustion.	Lower value, heat of combustion, B.t.u. per cu. ft. at 60° F. and 14.7 lbs. per sq. in.	Cu. ft. of air for perfect combustion of 1 cu. ft. of gas.	Heating value per cu. ft. of perfect mixture.
				D					H	A	
Air	.....	.....	1.2932	.080732	.07638	13.092	.....	.....	.....	.....	.....
Oxygen	O_2	31.76	1.4295	.0892405	.08442	11.846	.....	.....	.....	.....	.....
Nitrogen	N_2	27.86	1.2571	.078478	.07424	13.470	.....	.....	.....	.....	.....
Carbon dioxid	CO_2	43.66	1.9780	.12351	.11683	8.560	.....	.....	.....	.....	.....
Carbon monoxid	CO	27.78	1.2520	.07818	.07396	13.520	4380	4380	324	2.386	95.7
Hydrogen	H_2	2.00	0.08995	.0056154	.005311	188.29	62100	52230	277	2.389	81.7
Methane (marsh gas)	CH_4	15.90	0.7212	.04504	.04261	23.470	24000	21520	917	9.637	86.2
Ethane	C_2H_6	29.80	1.3900	.08681	.08212	12.177	22340	20350	1671	17.35	91.1
Ethylene	C_2H_4	27.80	1.2743	.07958	.07528	13.284	21900	20480	1542	14.61	98.8
Propylene	C_3H_6	41.70	1.9375	.12100	.11445	8.737	21420	20000	2289	22.21	98.6
Butylene	C_4H_8	55.60	2.5800	.16110	.15240	6.562	20900	19480	2968	29.59	97.0
Benzene vapor	C_6H_6	77.40	3.5900	.22420	.21210	4.715	18090	17330	3675	36.96	96.8
Acetylene	C_2H_2	25.80	1.1900	.07431	.070290	14.227	21860	21100	1483	12.25	111.9
Hexane	C_6H_{14}	85.40	3.8410	.....	.2268	4.410	.....	19950	4525	45.40	97.5

TABLE 2. DENSITY, HEAT OF COMBUSTION AND AIR OF COMBUSTION, FOR ELEMENTARY GASES.

Components.	Formula.	Volumetric Analysis, cu. ft. per cu. ft. Gas.	Density, lbs. per cu. ft.	Weight of each component per cu. ft. of Gas.	Lower value heat of combust. per cu. ft.	Heat of combst. of each component per cu. ft. Gas.	Cubic ft. air for combst. per cu. ft. of component.	Cu. ft. air for combst. of each component per cu. ft. Gas.
Illuminating Gas.		V	D*	D × V	H*	H × V	A*	A × V
Light Hydrocarbons taken as Benzene	C_6H_6	.006	.2121	.00127	3675	22.05	36.96	.222
Heavy Hydrocarbons taken as Propylene	C_3H_6	.038	.11445	.00435	2289	86.99	22.21	.844
Carbon Monoxide	CO	.076	.07396	.00562	324	24.63	2.386	.181
Oxygen	O_2	.008	.08442	.00068	.....	.....	.....	.....
Methane	CH_4	.362	.04261	.01543	917	341.90	9.637	3.489
Hydrogen	H_2	.398	.005311	.00211	277	110.24	2.389	.951
Nitrogen	N_2	.112	.07424	.00832	... .	.....	.....	.....
.....	.....	1.000	.....	.03778	.....	575.81	.....	5.687
Deduct for air not needed on acconnt of O in gas 4.782 x .008								.038
								5.649

* Values taken from Table 2.

575.8 ÷ (5.649 + 1) = 86.6 B. T. U. = Heat of Combustion per cu. ft. of Perfect Mixture at 60° and 14.7 lbs. per sq. in.

Additional results—Density—.03778 lbs. per cu. ft. at 60° F. and 14.7 lbs. per sq. in. Lower value heat of combustion,—575.8 B. T. U. per cu. ft. gas at 60° and 14.7 lbs. per sq. in. Ratio of air to gas in a perfect mixture—5.649.

TABLE 3. SAMPLE GAS CALCULATION FROM ANALYSIS.

Gas.	Average Volumetric Analysis. CO_2.	N_2.	CO.	H_2.	CH_4.	Unsat. Hydrocarbons as C_2H_6.	Lower value heat of combust. cu. ft. of gas at 60°—14.7 lbs. per sq. in.	Cu. ft. of air per cu. ft. of gas, perfect mixture.	Lower val. heat of combust. per cu. ft. of perfect mixture at 60°—14.7 sq. in.
Coal gas (illuminating)	.02	.03	.05	.45	.40	.05	622.1	6.159	86.9
Coal gas (weakest explosive mixture)	.....	.....	.....	.....	.....	.....	622.1	13.000	44.4
Coke oven gas	.02	.18	.03	.57	.19	.01	364.7	3.487	81.3
Air or Siemen's Producer gas (theoretical)	.....	.65	.35	.....	.....	.....	113.4	0.835	61.8
The same (actual)	.04	.62	.23	.08	.....	.03	165.4	1.406	68.7
Water gas (theoretical)	.....	.....	.50	.50	.....	.....	300.5	2.388	88.7
Water gas (actual)	.04	.04	.44	.49	.....	.....	278.2	2.220	86.4
Water gas (carburetted)	.04	.04	.25	.35	.18	.14	663.3	6.277	91.2
Producer gas (theoretical)	.....	.45	.39	.16	.....	.....	170.7	1.312	73.8
Producer gas (anthracite)	.07	.47	.27	.18	.....	.01	160.3	1.296	69.8
Producer gas (bituminous)	.04	.50	.22	.20	.....	04	218.3	1.890	75.5
Natural gas	.....	.08	.....	.02	.90	.....	830.8	8.721	85.4
Blast furnace gas	.10	.58	.30	.02	.....	.....	102.7	0.764	58.2
Oil gas	.....	.07	.....	.31	.46	.16	874.1	8.727	89.9
Acetylene gas (pure)	.....	.....	.....	.....	.....	.....	1,483.0	12.250	111.9
Carburetted air or gasolene gas, 2 gals. gasolene per 1,000 cu. ft.	.....	.....	.....	.....	.....	.....	214.2	1.203	97.2
Pure gasolene vapor	.....	.....	.....	.....	.....	.....	.....	.....	97.2
Pure kerosene vapor at 150°	.....	.....	.....	.....	.....	.....	2,526.0	31.110	78.7
Taylor anthracite (average)	.084	.527	.183	.174	.026	.....	131.3	1.075	63.3
Taylor anthracite (minimum)	.091	.569	.160	.152	.023	.....	115.0	0.943	59.2

TABLE 4. HEAT OF COMBUSTION OF GASES USED IN GAS ENGINES. BEST OBTAINABLE AVERAGE VALUES.

foot of the gas one degree, is practically the same for all of the mixtures we deal with, so that the final temperature and pressure of a cylinder full of gas do not depend upon the composition of the products of combustion.

Hence the only thing it is necessary to know is the total heat generated by the gas. In order to obtain the best results in most gas engines, the air and the fuel should be in about the proportion for perfect combustion. The air for the combustion of different gases varies greatly, and of course this air must enter the cylinder along with the gas. Therefore the criterion of the value of a gas for our purposes is the heat of combustion of a cubic foot of a perfect mixture of air and gas. That is, the power of a gas engine of a given size depends almost directly upon the heating value of the gas per cubic foot of perfect mixture. This, then,

Oil Gas	1.00
Water Gas (uncarbureted)	1.00
Coke Oven Gas	.93
Air Gas (Siemens Producer Gas)	.79
Carbureted Water Gas	1.05
Anthracite Producer Gas	.80
Bituminous Producer Gas	.87
Blast Furnace Gas	.67
Acetylene Gas	1.28
Gasolene (liquid, vapor, or vaporized and mixed with air)	1.12
Kerosene (vaporized alone or mixed with) air, and entering cylinder at about 150° F.	.90
Taylor Producer Gas (R. D. Wood Co.)	.73

The M. E. P. for any gas is found by multiplying values of Table 1 by these factors.

TABLE 5. RATIOS OF HEAT OF COMBUSTION PER CUBIC FOOT OF PERFECT MIXTURE, TO VALUE FOR AVERAGE NATURAL GAS OR MANUFACTURED ILLUMINATING GAS—87.

is the first thing to be computed or ascertained in designing a gas engine.

Table 2 gives the heat of combustion and air for combustion per cubic foot, for all of the usual elementary gases.

Table 3 gives a scheme for computing from these the "Heat of Combustion per Cubic Foot of Perfect Mixture" for any gas, from a volumetric analysis. Sometimes the density of the gas and the heat of combustion of a cubic foot of gas are also desired and these are therefore added to Table 3 for the sake of completeness.

Table 4 gives the average volumetric analyses of various gases commonly used in gas engines, and the values of the "Heat of Combustion per Cubic Foot of Perfect Mixture," as computed by the method of Table 3. The last column of Table 4 therefore gives relative value of the various gases for gas engine purposes.

The ratio of the values of "Heat of Combustion per Cubic Foot of Perfect Mixture" for two gases is also the ratio of the powers produced by the gases with a given cylinder, or the ratio of the mean effective pressures. Hence the ratios of the numbers in the last column of Table 4, to the number for average illuminating gas, 87, gives a set of factors as given by Table 5, for deriving the mean effective pressure for any gas from Table 1.

RATED BRAKE HORSE-POWER AND INDICATED HORSE-POWER.

The rated brake horse-power is the nominal power for which an engine is sold. It is customary to have the cylinder of such size that it can deliver about one-eighth more power, that is, stand 12½ per cent. overload.

The values of Table 1 correspond to the area of the indicator card, and are to be used in computing the indicated horse-power, or I. H. P. The ratio of this to the maximum brake horse-power is called the mechanical efficiency. This averages about .80. That is, the maximum brake horse-power is about 80 per cent. of the indicated horse-power. Hence the rated brake horse-power must be multiplied by the factor $\frac{1.125}{0.80}$ or about 1.4 to give the indicated horse-power.

SIZE OF CYLINDER FROM MEAN EFFECTIVE PRESSURE AND INDICATED HORSE-POWER.

Having found the indicated horse-power from the considerations given in the last paragraph, and selected the mean effective pressure from Table 1, using a factor from Table 5 if necessary, and selected some method for deciding ratio of length to diameter of cylinder, and rotative or piston speed, the matter of deciding the cylinder dimensions is only a question of arithmetic.

The fundamental relation is

$$I.\ H\text{-}P. = \frac{(M.\ E.\ P.)\ L \times a \times x}{33{,}000}$$

where L is the stroke in feet, a is the cylinder area in square inches, and x the number of explosions per minute, which is half the revolutions per minute in a four-cycle engine at maximum power. This reduces to

$$I.\ H\text{-}P. = \frac{(M.\ E.\ P.)\ l \times d^2 \times N}{1{,}008{,}500}$$

where l is the length of stroke in inches, d is the cylinder diameter, and N the revolutions per minute. If we determine speed by selection of a value for piston speed, in feet per minute, the above equations reduce to

Diameter of cylinder (in inches) =

$$410\sqrt{\frac{I.\ H\text{-}P.}{M.\ E.\ P \times Piston\ Speed}}$$

Then the length of stroke is about one and one half times the cylinder diameter, and the rotative speed is calculated from the piston speed, the relation being R. P. M. = 6 × piston speed ÷ length of stroke in inches. If we decide rotative or piston speed according to the rational rules above discussed, taking $\frac{800}{\sqrt{l}}$ as the value for the revolutions per minute, we have the following:

Diameter of cylinder (in inches) =

$$355\sqrt{\frac{I.\ H\text{-}P.}{M.\ E.\ P. \times \sqrt{l}}}$$

where l is the length of stroke in inches. This equation is best solved by trial and error. A value of l is to be guessed at, and the corresponding value of d found. If the resulting ratio of l and d is not desirable, a new value of l is to be assumed. The value of l will be found to have little effect on the value of d. By making a few trials, values of l and d can be found, having a ratio of about 1.5. The rotative speed is then found from the relation R. P. M. = $800 / \sqrt{}$

The Value of Articles in Technical Journals—Oslerism in the Machine Shop—Some Things Suggested by a Visit to City Shops.

BY E. R. PLAISTED.

I have long contended that one can get a better insight into the working and construction of a complicated machine from a carefully written and illustrated magazine article than from ordinary observation and examination of it. A recent trip to some of the largest New England cities and their machine shops has given me a chance to compare the advantages of the two ways of seeing—through one's own eyes and through the eyes of the camera and the technical journalist.

Possibly my experience was an exceptional one but it certainly brought home to me how mighty effectual is our modern technical press in giving one a thorough and comprehensive idea of something one has never seen; not only does this apply to the machines but to the shops where they are built. Of course a personal inspection supplements and extends the knowledge gained by reading, and vice versa, but in traveling up and down endless rows of machines, from room to room and building to building, I failed to gather as correct an idea of the plan and magnitude of the shops I visited as I get from a good magazine article.

The backwoods draftsman who is shut away here in the mountains from contact with his mechanical kind has to depend in a large degree on the technical papers and trade literature to keep in touch with the progress made in mechanical lines; as a result of my trip I picked up some "points" and detailed information that I would have missed otherwise but I came home with a new respect for the efficiency of the technical papers and also for the equipment and efficiency of the backwoods machine shop and drafting room.

I have no intention of wearying you with the details of what I saw; though so new and interesting to me they are doubtless mostly old stories to your readers in general; I will mention but two conditions which I found in sharp contrast to what I have become accustomed to here. Possibly even those who are most familiar with them in the cities may gain a new point of view from the impression they made on the understanding of a receptive backwoodsman.

I had expected to find "red tape" much more in evidence than at home, and I was

not disappointed. Also I had expected to find the newest and most efficient apparatus in almost universal use, and I was disappointed. In a drafting room employing over half a hundred men I found them all using the parallel ruling device invented, I think, by Bergner, and which I abandoned to return to the Tee-square over a dozen years ago. I believe I am not the only one of your correspondents who claims to be able to turn out much more work in a day by using the Tee-square on both front and end of the board than by drawing all verticals, regardless of their length, with the triangle. After using the Universal drafting machine for a couple of years I should much dislike to go back to either of these, but of the two I would take the square in preference to the parallel ruler, both as regards ease and comfort in working and in time saved.

I suppose "red tape" is much more essential in the management of a big shop in either city or country, but one can easily have too much of it, even in the biggest of them. My information on this point is second hand but I believe it reliable. I was told by a young machinist who had recently left the home shop that he would be glad to get, for fine fitting, many of the files we send into the casting cleaning room, and that it took about ten minutes of formality and folderol to get a little wad of waste no bigger than all our men constantly carry in the hip pocket.

From this it seems a rather open question whether the country shop was really extravagant with its files and waste or whether the city shop is spending dimes in the effort to prevent a waste of pennies. We do not consider it true economy to keep a high-priced machinist fiddling away with a badly worn file, and the life of a file depends not on the length of time it has been in use but on the amount of work it has done..

But the thing which made by far the most powerful impression, and which-condition seemed common to all the city shops, was the scarcity of workmen who could be called old, or even elderly.

This struck me as being so strange that I immediately asked if they now practiced Oslerism down that way. My informant would not admit such to be the case but he did say they practically never hired any but young men and that when these grow old they drop out. *When they grow old they drop out.* Where do you suppose they drop to? At the risk of again getting into water too deep for me, as I did by my first reply to Entropy, I submit this problem.

It hardly seems probable that the percentage of workmen who accumulate enough property before reaching the age of 50 to enable them to retire from active work is greater in the city than in the country; it is, doubtless, much smaller, and even if such were the case is it wise to compress the growth, education, and accomplishment of a normal life time into the first fifty years? Is it not better to mix in a little more relaxation with the "strenuousness" of the earlier years and so prolong the usefulness of those that should come after experience has ripened the judgment and while the hand yet possesses its skill and strength? Does it pay to keep the pace so hot that all a man's energy and usefulness have been burned out at 50? Some might say the law of the survival of the fittest will take care of all this without need of fret or worry on the part of anybody. I hope it will, but with man's propensities for improving on nature this law has become somewhat inoperative.

We take the kittens nature would have drowned, exterminate their microbes, deodorize them, fatten them on peptonized "hygienic" foods, and exhibit them at the cat shows; and it must be admitted that once in a while one of these puny things does prove a prize winner.

Speaking for myself, I'd much rather take the speedy exit recommended by the heathenishly humane Doctor, even at 35, than endure the high-pressure existence that modern commercial conditions have forced upon a great many people. And as long as this is denied us, both by law and by religion, I mean to take good care that my last years shall not be spent in nursing a broken down stomach and shattered nervous system. My theory of the value of dumb-bells in a drafting room is applicable in much wider fields; it is the quality of a man's thinking that counts, not the mere quantity of it, when his work is of a sort that demands thinking at all. It is much like the case of the file, after all. It doesn't pay to use one after it is too dull, it doesn't pay to toss it aside before it is worn out, and a few misplaced strokes when that file is new go a long way toward determining its life and efficiency.

A good many years ago, while making plans for re-modeling a small manufacturing plant in New Hampshire (which is nevertheless, the largest of its kind in the world) I was so struck by the remoteness and isolation of the place that I asked the wealthy proprietor why he did not build the new shop in some large town. At the time I did not take in the full meaning of his answer, which was that if he were to move to such a place he would feel that he had lost his identity, that, in our homely Yankee metaphor, he would sooner be a big toad in a small puddle than a small toad in a big puddle. After contrasting my drafting room with some where so many men are employed I think I can better appreciate the significance of the New Hampshire man's reply. The advantages of country life are not so great that I would willingly locate on a hill farm, "forty miles removed from a lemon," but I would prefer even that to some jobs that command good wages in the cities.

To get back to my point again, the scarcity of old men in the city shops: How different it is in some of the largest and best of the rural shops, notably that of the Fairbanks Scale Company at St Johnsbury, the Vermont town that Tecumseh Swift seemed to think was a close approach to the ideal as a residence for a workingman. There they are proud of the fact that some of their workmen have been with them for a score of years after passing the Osler limit, and the well preserved appearance of these old patriarchs of the machinist's trade shows that they are still of much use in the world—more useful in some ways than many a younger man.

Regarding the value of a well illustrated description of a machine, I do not call to mind a better instance than the new Jones & Lamson turret lathe. At the time this came to my notice in the AMERICAN MACHINIST we had had one of these in operation several weeks and I had spent a good many odd moments in watching it at work, as well as longer periods of prying into its design and construction when it was not in use. It is my belief that I learned more of the true inwardness of that machine in a single hour's reading than in all the time I had put in on the thing itself.

Looking back on my trip (and a perspective view is usually the truest one) I am very glad I went and shall try to go oftener in future. There are ways in which the large shop must always be ahead of the small one, regardless of its location, and a man who travels with his eyes open cannot fail to find a few things new to him that he can apply to his own work with advantage; but in spite of this, as I before remarked, I came home with a new respect for the backwoods machine shop and the backwoods drafting room, both as to their equipment and their methods.

The *Engineering Record* calls attention to the desirability of finding some way of changing blueprints to a color which is more readily photographed, as for instance green. Where it is the practice to make assembly drawings by tracing from photographs to a reduced scale of the details, or to preserve by photography records of large drawings which come into an office, it is found that some of the blueprints do not give good negatives. The blue has been changed to a green which rapidly fades away, but a more permanent process is needed.

The diameter of the iron in the link in eighths, squared and divided by nine, gives the safe load in tons for chains.

Engineering Reminiscences.*

BY CHARLES T. PORTER.

In resuming these reminiscences, I shall not confine myself altogether to a regular sequence of time, but shall take up whatever I remember, sometimes without regard to its connection and sometimes also without much association with engineering.

I fancy your readers may be amused with accounts of how I got into England, and how I got out of Portugal, after the opening of the Oporto Exposition.

Being anxious to reach London as quickly as possible, after a tedious voyage of twelve days on the old "Africa," I left the steamer at Cork, to go through with the mail. The custom-house inspectors first interested me. On the little boat by which the mail is transferred from the ship to the shore, two of the representatives of the Queen were anxious to know if I had any liquor or tobacco in my trunk. They were quite satisfied with my reply in the negative. A personal examination they never thought of. Truthful themselves, I moralized, they do not suspect untruth in others. Their next question was, "Have you got the price of a glass of beer about you?" I made them happy with a half crown, several times their modest request, and stamping me as an American, free with his money. I purchased a first-class ticket to London and received the assurance, that I should go through with the mail. I was the only passenger on the train of two coaches, besides the mail van. It was late at night. The regular passenger train had gone some hours before. Not being up in the English ways, I did not know how I might make myself comfortable, but sat up all night, dozing as I could. I did not sleep after two o'clock. In that high latitude it was already light enough to see fairly well.

After that hour the railroad ran through a farming country all the way to Dublin. I was amused with the queer shapes of the fields. These were generally small, and running into sharp corners, regardless of convenience in cultivation. They were separated always by hedges and ditches. A ditch was dug some two feet deep and three or four feet wide, the dirt was thrown up into a bank to correspond on one side, and on this bank was planted a hedge of hawthorn—"quickset" they commonly called it. These hedges were of all ages, from those young and well kept to those in all stages of growth and dilapidation. I could have passed everywhere from field to field through breaks in the hedges, sometimes wide ones. I could not see of what use they were except for hunters to jump over. Saw occasionally a laborer's cabin, sometimes a group of them. When an Irishman came out to sun himself, he always stood higher than the eaves of his thatched roof. Occasionally a more pretentious house would appear. These were all alike, painted white, full of windows, very thin from front to back, and looked like waffles set on edge. Never did I see a tree or a bush about a house to relieve the appearance of barrenness.

The railway station on one side of Dublin was about four miles from the station on the opposite side, from which a short railway ran to Kingston, a point a little distance south of Dublin, from which the channel boats crossed to Holyhead. There being no other means of conveyance, I rode through Dublin in an open van sitting on the mail bags. At the Kingston station an empty train stood waiting for the mails. There also the regular passenger train had gone some time before, but the boat at Kingston was waiting for the mail. I got into a carriage, having ordered my trunk put into the baggage van, but was ordered out by the guard. I showed him my ticket, and was told that I would have to see the superintendent. That official appeared, and told me this train was for the mails. It had an empty passenger coach. I showed him my ticket and told him the assurance on which I had bought it, that I should go through with the mails. He replied that the passenger train had gone, I should have been here to take it. Said he was very sorry, but it was impossible. I got mad. My trunk stood on the platform. As nobody would touch it I took it up and put it into the open door of the baggage van myself. The superintendent ordered two men to take it out, which they did. I told him of my great anxiety to reach London that afternoon. All the reply he made was, to repeat that he was very sorry, but it was impossible, and I was compelled to stand there and see the train move off, and fool away the whole day in Dublin. Does the reader want to know what the matter was? If he does not know already, he is as green as I was. I had not given the superintendent two and sixpence. But I had more yet to learn about England and the English, and much more serious.

Now for the way I got out of Portugal. I went without a passport. Our financial partner told me it would be quite unnecessary. He himself had just returned from Oporto, where he went without a passport, and found that half a crown given the custom-house inspector on his arrival and departure was all he needed. I understood the intimation that if I got a passport, the fee of, I believe, a guinea would not be allowed me. So, although I went from London, and could very conveniently have obtained a passport at the United States legation, I omitted to do it. On landing at Oporto, the two and sixpenny piece opened the kingdom of Portugal to me quite readily. Getting out, the process was different. I found that the steamer on which I had come from London would not return for a week or more after the opening of the Exposition, and I was impatient to get back. A line between Liverpool and Buenos Ayres made Lisbon a port of call and a steamer was expected en route to Liverpool in the course of three or four days after the opening; so I determined to come by that. The morning after the opening I was awakened early by a telegram, informing me that the steamer had arrived at Lisbon during the preceding night, having made an unexpectedly quick run across the south Atlantic, and would sail for Liverpool that evening. The railroad ran only two trains a day, and my only way to get to Lisbon in time was to take the nine o'clock train from Oporto. The station was on a hill on the opposite side of the Douro. There was only one bridge across the river, and that was half a mile up the stream from the hotel and from the station. Oporto boasted no public conveyance. So I hired a couple of boys to take my trunk down to the river, row me and it across, and carry it up the hill to the station. I got off with two minutes to spare.

On applying at the steamship office in Lisbon for a passage ticket, I was informed by the very gentlemanly English clerk that they were forbidden to sell a ticket to anyone without a passport. "However," he added, "this will cause you no inconvenience. The United States legation is on the second block below here. I will direct you to it, and you can obtain a passport without any trouble." By the way, how did he recognize me as an American, and how was it that I was always recognized as an American? I never could explain that puzzle.

On knocking at the door of the legation, it was opened by a colored man, who informed me that this was a fête day, and the minister was attending a reception at the palace (this was the first time I ever heard of a royal reception in the forenoon), but if I would call again at three o'clock, the passport would be ready for me. So, leaving with him my address, I left, to amuse myself as best I could till three o'clock.

On presenting myself at this hour, I was informed by the same darkey that the minister would not give me a passport; that he had bid him tell me he knew nothing about me; I might be an American or I might not; at any rate he was not going to certify that I was. I had got into the country without a passport, and I would have to get out without one for all him. I inquired if the minister was at home. "Yes, sir," replied the darkey, "he is at home, but he will not see you; he

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told me to tell you so," and with that he bowed me out and shut the door.

I went back to the steamship office and reported my failure to my friend the clerk. He drew a long whistle. "Not see you! What's he here for? He must be drunk; that's it, he's drunk." After a minute's reflection, he added: "We must see the Secretary of State—I am well acquainted with him, and he will get you out of this mess directly. If you will kindly wait till I have finished my correspondence, which will occupy me for about half an hour, I will take you to his office. You can amuse yourself with this copy of the *Times*," handing it to me.

When we reached the office of the Secretary of State we found the door locked. "Oh," said he, "I had forgotten, this is a saint's day, and the public offices are closed. We must go to his house." We found the Secretary at home. I was introduced and the Englishman told my case, of course in Portuguese. As he proceeded I saw the official brow darken. I woke up to the enormity of my offense. Little kingdom, big dignity. I had defied their laws and corrupted their official. The case looked serious. The Secretary, in fact, found it so serious that he did not feel like taking the sole responsibility of its decision, but sent out for two others of his majesty's advisers, to consult with him. The assembling of this court caused a delay of half an hour, during which I had time to conjure up all sorts of visions, including an indefinite immurement in a castle, and a diplomatic correspondence, while the deuce would be to pay with my business at home.

Finally the officials sent for arrived. The instant they entered the room I was recognized by one of them. He had accompanied the King to the opening of the Exposition the day before, which the pressure of public business, or some game or other, had prevented the Secretary of State from doing. In fact, he had headed the procession behind their majesties and so had seen the graciousness of the King's favor to me.

He spoke a few words to the Secretary of State, when, presto! everything was changed. The court did not convene; but instead cordial handshaking with the man on whom the beams of royal favor had shone.

I left my smiling friends with a passport, or something just as good, added my twelve pounds sterling to the account of the ship, and had time before it sailed to eat a sumptuous dinner at the hotel. I was in the land of olives, and ate freely of the unaccustomed delicacy, in consequence of which I lost my dinner before the ship was well out of the Tagus, and have never cared much for olives since.

I was full of wrath against the United States Minister and determined to send a protest to the State Department as soon as I reached Manchester. But there I found something else to attend to and dropped it. I read, however, with satisfaction, a few months after, that the item of the salary of the Minister to Portugal had been cut out of the appropriation bill by the House of Representatives.

The following incident near the close of my experience in Harlem would be too ridiculous to print except for its consequences. One day Mr. Smith sent me word that he would like to see me in his office. When I entered he asked me: "What do you pay for the castings of your governor arms and balls?" Of course he knew perfectly well, as he had the bills and the books, but that was his way of introducing the subject. I replied, "Forty cents a pound." He held up both hands in affected amazement, and exclaimed: "Forty cents a pound! Well, sir, I can assure you of one thing, no more of this company's money is going to be squandered in that way." I overlooked his insulting language and manner, and said quietly: "Are you sure, Mr. Smith, that you have all the information you need to form a correct judgment in this matter?" "I am sure," he replied, "what the market price is of copper and tin, and that I can get castings made from our own metal at a price that will bring the cost to not more than 25 cents a pound."

"This, then, I presume, is all you know about the subject," I said, "and you ought to know a great deal more, which I will tell you. It is necessary that I can rely upon getting a pure copper and tin alloy, in the proportion known as gun metal, on account of its strength, its rigidity and its wearing qualities. The latter is of especial importance, because the governor joints are in continual motion under the weight of the heavy counterpoise. Experience shows that this purity cannot be relied upon, where it is possible that any inferior metal can become mixed with this alloy in even the smallest proportion. This for us, not making our own castings, must be wholly a matter of confidence.

"Another risk must be avoided, that is, of getting bad castings. The castings must not have the least imperfection. The time lost, through finding defects that make it necessary to reject arms after more or less work has been put on them, would soon wipe out all the little gain you look for; as these castings, at 40 cents a pound, only cost about $5 a set, as an average of all the sizes.

"I made a careful study of this subject when I commenced the governor manufacture, about 15 years ago, and found David Francis, who had a small gun-metal foundry on Vestry street, to be just the man I wanted. No inferior metal ever goes into his place. He enjoyed the entire confidence of manufacturers. He has made my governor arms and balls ever since. I have never had a bad casting from him, and have always got the pure metal, and have paid him the same price that everybody pays him for small castings. I consider the security that I have had respecting this metal to have been fundamental to the great success of my governors, and that I would be crazy to make any such change as you propose."

He made no reply, and I left him, supposing my statement to have been perfectly satisfactory. What was my amazement when, a few days after, he informed me that he had made a contract with a brass molder on Rose street, for casting our governor arms, "subject to your approval, sir," and he asked me to visit the place and see what its facilities were.

I told him I would go, but that my position on the subject was already well known to him. I found the place on a little lane, and that the business done in it was making brass castings for plumbers. The proprietor told me he had never made gun-metal castings, but he could make any kind of composition, and I could rely on getting them of just the metal I furnished him.

I reported to Mr. Smith that such an arrangement would be ruinous, that his plan of furnishing the metal was most unbusiness-like. "What do you know about business?" he shouted, with a sneer. "I know," said I, "that if you should propose this plan to any well-informed, practical man, he would laugh in your face, and tell you if you wanted to ruin your business, this would be as good a way as any to do it." He replied, "That is not the question, sir; the only question is, will you, or will you not, approve the contract I have made?" "I will not," I replied, and walked out of his office.

A few days after, I received a note from Mr. Hope, asking me to call on him. I called next day, and he told me that Mr. Smith had been to see him, with a bitter complaint of my insubordination and defiance of his authority, which he would not endure; and he asked me to tell him what the trouble was about. I told him substantially as above related. "Is that all?" said he. I assured him that it was all the trouble that I knew of. Mr. Hope replied, "I cannot express my amazement at his interference with your management. That must be absolutely entrusted to you, and he ought to see it. He is a rational man and I can easily show him his error, and that you *must* take the stand you have done. I don't think you will have any more trouble."

I did not hear again from Mr. Hope for a fortnight, during which time I had no occasion to meet Mr. Smith. Finally a letter came from him, telling me that I must prepare for the worst; he had exhausted all his efforts on Mr. Smith, and found him absolutely immovable, declaring that I must go, I was of no use there, anyway. Mr. Hope said he told him his conduct was outrageous and suicidal. If I went, then it would be the end of the business. He snapped his fingers at that, saying, "Mr. Goodfellow can make the

engines, and I can sell them; what more do you want?" He declared that no business could succeed unless the will of the president was law. They had several very disagreeable conferences, which Mr. Smith always closed by saying, "Repay me my investment in this company," which he figured at $24,000, " and I'll give you my stock." He had announced to Mr. Hope his determination to call a meeting of the directors to discharge me, and as he had a majority of votes, having some time before given to each of his two sons qualifying shares and had them elected members of the board of directors, he held the power in his hands to do it.

Directly after, I received a copy of a notice of a regular meeting of the board, convened strictly according to the law. I could see no ray of light. The night before the meeting I walked the Third avenue bridge half the night. The meeting was called to order by Mr. Smith at the appointed hour. Mr. Hope was absent. Mr. Smith said Mr. Hope had sent word to him the day before that he might be detained, but if so would come up on the next boat, which ran hourly, and asked Mr. Smith to wait that time for him.

So the meeting was adjourned for an hour, when Mr. Hope arrived.

Mr. Smith prefaced the resolutions discharging me from my position as superintendent and electing Mr. Goodfellow in my place by quite an oration, setting forth the solemn sense of his Christian duty which left him no alternative, and the necessity of proper subordination in any business, if it was to be successful, and the especially aggravated character of my offense and the demoralizing nature of my example.

He was about to put the question on the adoption of the resolutions, when Mr. Hope said: "Before you put this question to vote, Mr. Smith, I would like to say a word. I have concluded to accept your offer. Here is my certified check for $24,000 to your order, and I demand from you the transfer to me of the stock in this company standing in your name and the names of your sons."

When the Smiths were gone (they left by the next boat) Mr. Hope and I sat down to confer on the business of the company. When these matters were concluded, I said to him, "Mr. Hope, if you had determined to make this grand proof of your confidence in the engine and in myself, why did you not tell me sooner, and save my wife and myself a great deal of distress"

"My dear fellow," he replied, " I did not know till this morning that I should be able to do it. That is why I was late."

In the autumn of '72, following the above incident, we had a proof of the sagacity of Mr. Smith in rejecting my plan for the establishment of works for the manufacture of the engines, and taking a five years' lease of an abandoned shanty. The property had changed hands, and we received a note from the new owner, saying that he had purchased the property with a view to its improvement. He should therefore be unable to renew our lease, and he gave us six months' notice, that we might have time in which to make other arrangements before its expiration.

Here was a situation. To move and establish the business in a new locality would require a large expenditure, and we had no money. The natural thing to do would be to enlarge our capital. On consultation with several parties, Mr. Hope found the financial situation at that time would not warrant this attempt. The Civil War had ended between seven and eight years before. Hard times had been generally anticipated after its close, but to the surprise of capitalists these did not come. The country continued to be apparently prosperous. The best observers were, however, convinced that a financial reaction was inevitable, and the longer it was delayed the more serious it was likely to be; an anticipation that was more than realized in Black Friday in 1873, and the collapse of values and years of absolute stagnation that followed.

For some time before that eventful day capitalists had felt anxious, and there had been a growing timidity and indisposition to invest in any enterprise, however substantial it might be, so there was nothing for us to do but to wind up our business and wait for more propitious times, when we might attempt its revival.

In the winter of '72-3 I had a call from my friend, J. C. Hoadley, accompanied by Charles H. Waters, manager of the Clinton Wire Cloth Company. Mr. Waters wished to obtain one of our engines. I told him I was very sorry, but we should not be able to make one for him. I then explained our situation. Our lease would expire in a month or two, and could not be renewed, and we had made arrangements then to close our business, had sold all our tools deliverable before that date, were rushing two engines to completion, but absolutely could not undertake another order.

"Never mind," said he, "one of your engines I must have." He then told me that he was about to introduce a new feature in weaving wire cloth. This was then woven in various narrow widths, according to customers' orders, having a selvage on each side. He had satisfied himself that this latter was unnecessary. The wire, being bent in weaving, had no tendency to ravel, and he had planned a loom to weave the cloth seven feet in width and slit it up into narrow widths as required. In this loom the shuttle alone would weigh a hundred and fifty pounds, besides the great weight of wire it would carry; it had to be thrown nearly twelve feet, and he wanted to make as many picks per minute as any narrow loom could do. In order to make these throws uniformly, he required absolutely uniform motion. From a careful study of slow-moving variable cut-off engines, he had satisfied himself that none of them could give him the uniformity of motion he needed. They were driven by a succession of violent punches, these excessive amounts of force at the commencement of each stroke were absorbed by the fly-wheel, the velocity of which had to be increased to do it, and at the end of the stroke its velocity had to be reduced in the same degree, to supply the total failure of the force of the steam. This involved a variation of speed which in ordinary business would not be regarded, but which would ruin the action of this new loom. In the high speed of my engine, and the action of the reciprocating fly-wheel, which compensated the inequalities of the steam pressure without affecting the uniformity of the speed, he found just what he needed, and that engine he must have. I was astonished at the man's penetration.

I was able to get from our landlord and purchasers of our tools the necessary extension of time, and made the engine for him. It and the loom were each a complete success. Mr. Waters told me long after that he never observed a single variation from exact uniformity of motion, without which his loom would have had to be abandoned.

I had one day the pleasure of meeting there the president of the Lancaster mills, the only other great industry of Clinton, who had come over expressly to examine the running of our engine. Before he left he said to me that the engine certainly presented a remarkable advance in steam engineering.

I saw there one thing that interested me greatly. That was the method of painting wire cloth. This was carried on in a large tower high enough to enable a twenty-yard length of the "cloth" to be suspended in it. This was taken through a tub of paint, and drawn slowly upward between three successive pairs of rollers, the last pair, of india-rubber, held firmly together. By these the paint was squeezed into every corner, both sides were thoroughly painted, and the surplus paint removed, so that every mesh was clear, a uniform perfection unattainable by hand painting, and two boys would paint in ten minutes as much as a painter could paint in a day. I think this was an invention by Mr. Waters.

What is claimed to be the smallest electric motor in the world is in the possession of a Texas electrican and watchmaker, who made it as a scarf-pin. It weighs one pennyweight and three grains, and is run by current from a small silver chloride battery. The field magnets are made from two very fine pieces of sheet iron scraped down and polished. Instead of copper as a conductor gold is used. The magnets are held together by gold screws and wound with very fine silk-covered wire, and the commutator bars are of gold.

Letters to the Editor.

Commercial Work in College Shops.

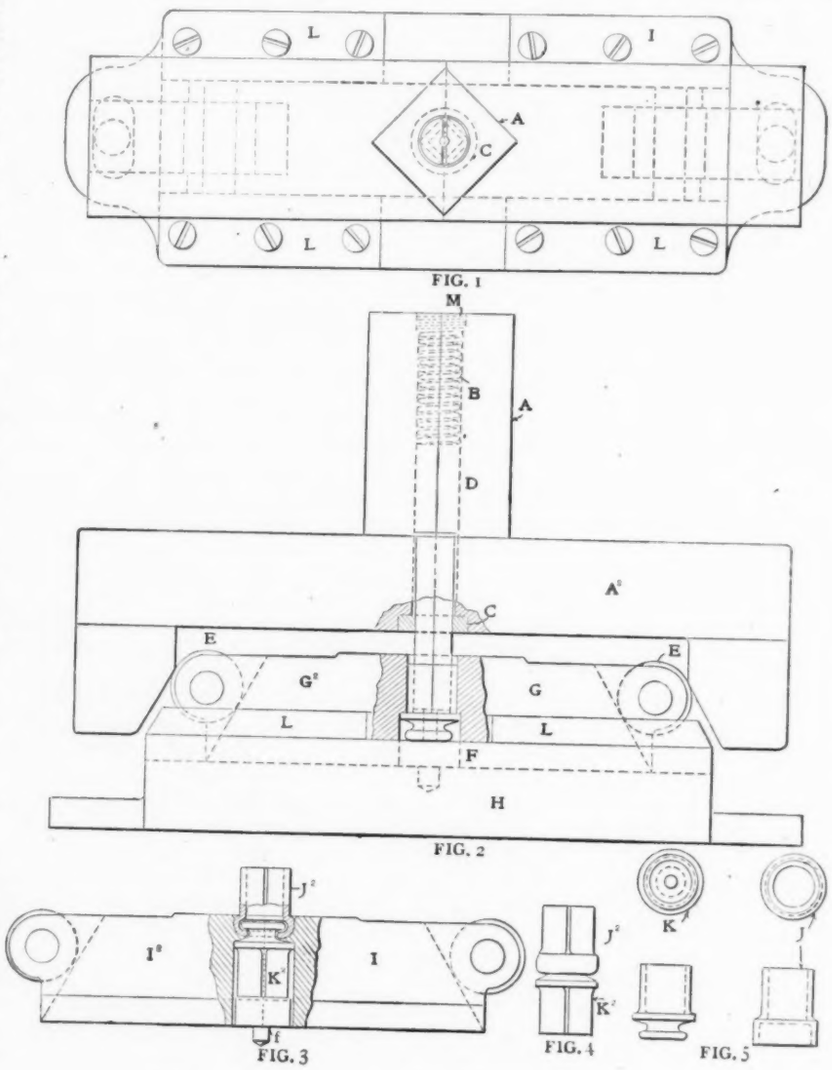
Since reading the report at page 173 of Professor Jacobus' address on Investigations and Tests in Connection with College Work, I have run across a parallel to what he suggests which seems to me worth reporting. It was at the Worcester Polytechnic Institute, where, as your readers know, they have quite extensive shops run on commercial work, with paid as well as student workmen. The amount of work which they are doing was a surprise to me; for, if I remember correctly, their yearly output is valued at about $50,000. At this school the mechanical department (which controls the shops) seems to me to be pushing its work along lines of production engineering rather than consulting engineering. This being the case, just see the chance which instructors in that department have of holding their places and still keeping in touch with actual commercial conditions and practice. The practical and the theoretical are so constantly intermingled that the step from one to the other is only a matter of seconds. Work is constantly going on in their shops, both manufactured in quantity and special work going through in single machines.

Whether their methods are all up to the minute or not, I could hardly judge; but the principle of the thing is there, and they certainly have every opportunity for keeping up to date that any shop has, for they are in open competition with other commercial shops. This practical feature of the work is not confined to those actually teaching in the shops, but other men of the department seem to feel it. For instance, I found the boys in their drafting work getting out the drawings for some twenty or thirty different machines or devices, all of which may be, and most of which surely will be, built in the shops. These machines (it was one of the lower classes that was making the drawings) are really designed by the instructors and the drawings are made to certain specifications, as much as possible being left to the students to design themselves. The drawings, when complete, will be used in the shops for the other students to make the patterns from. Up to that stage the cost of new machinery is only that of the paper and lumber used, less what would have to be used for purely instructive purposes, and which comes to practically nothing. The machine work may be done, as much of it as is suitable, by students, and if the machine is wanted soon, it may be pushed through by journeymen. The whole thing seems to work along so well, and to give the instructors so good an opportunity to keep in touch with the commercial world, that it seems worthy of more publicity than it has had so far.

ENTROPY.

Making Swivels of Brass Castings in the Punch Press.

The accompanying drawings show tools designed by me for making the swivel connection shown at Fig. 4 and partly in section at Fig. 3. Probably the most noteworthy feature is that the pieces operated on were red brass castings; shown at Fig. 5. Our old process of making this swivel was to cast the parts *K* Fig. 5, cut them off from the gate, grind and water tumble them. They were painted on the button end with a mixture of cylinder oil and graphite, then rolled in dry core sand and baked. This process, it will be readily seen, formed a coating over that end which enlarged its diameter. Next the pieces so treated were placed in a mold that formed the opposite end *J* also, which was poured, making the complete swivel. They were then taken from the sand, given another water tumbling and then loosened up with the aid of a boy and a speed lathe. Occasionally we would get a straight one but the whole process and product was far from satisfactory. The swivel shown at Fig. 4 was used as a hydrant plunger connection and was connected at one end to the plunger stem and at the other end to a 7-16-inch square rod, which terminated in a brass screw of coarse pitch by means of which the plunger was moved vertically in the barrel, the object being to so connect with the plunger that it would not rotate. In making this swivel on the punch press the parts *K* and *J* Fig. 5, were cast with a little more than ordinary care to insure a fair degree of uniformity. The first press operation shown at Fig. 2 consisted of squaring or closing both pieces to a 7-16-inch square pilot *D* which normally extends sufficiently beyond the point of contact of the angular ends of A^2 with the rolls in slides *G* and G^2 to insure it entering the hole in the casting before the squaring dies *G* and G^2 begin to act. In setting the piece *K* in the die, it is located centrally by a small stump *F* having a small end to suit the hole in the button end of *K*. The piece *K* is similarly located and both parts are squared in the same die. The action can readily be seen by an inspection of Figs.



MAKING SWIVELS OF BRASS CASTINGS ON A PUNCH PRESS.

1 and 2. The spring *B* served to keep the pilot or former bar always out of the die to a distance sufficient to insure it first entering the piece to be squared, while it was kept in proper location to the squaring dies by the inserted guide collar *C*. The screw *M* served as an upper abutment for the spring. The closing in or connecting operation was performed by the dies *I* and I^2 shown at Fig. 3 being inserted in *H* in place of the squaring dies. A plain shank or tool having an end of the same diameter as the collar *C*, was inserted in *A* and A^2 instead of the former bar *D* and served as a driver to force J^2 Fig. 3 down and curl it around K^2 as shown. The hight of rolls and dies, Fig 3, was made so as to permit the tool *A* and A^2 to be used for all three operations. The process proved quite satisfactory both as to quantity and quality, though at first I did entertain a doubt as to the success of so heating a *casting* but the results proved that the doubt was unfounded as tests made showed it to be materially stronger in every way than the old one which contained over three ounces more metal.

Brooklyn, N. Y. H. J. WHITE.

Lathe Design and Practice.

The valuable articles which have recently appeared in your columns on lathe design would seem to leave small room for anything further on the subject, but the following may be interesting to some of your readers.

Some time ago I was engaged in the building of high-speed lathes, ranging from 8- to 16-inch centers. The driving headstocks were all fitted with spindles which ran in gun-metal parallel bearings, the boxes being made in halves. The spindle bearings were all scraped to a fit by hand. We had, however, considerable trouble with hot bearings on the larger machines. It was found, as Mr. Fish states, that when the caps of the bearings were fixed down tight the gun-metal boxes opened a little at the joint, no matter how carefully they had been fitted. This opening out, shown exaggerated at *A*, Fig. 1, could only be noted from the small film of oil which showed. Scraping away the bearing at top and bottom, thus allowing for the opening of the boxes, removed to a large extent the cause of the trouble; though how much to scrape away was purely a matter of judgment. This would seem to be the reason why some makers build their large lathes with the spindle boxes fixed in square holes in the headstock. Fastening the halves of round boxes in their place by means of screws, as shown in Fig. 2, might be an improvement.

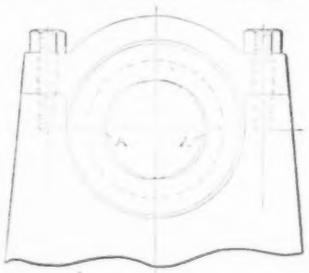


FIG. 1

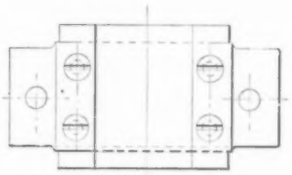


FIG. 2

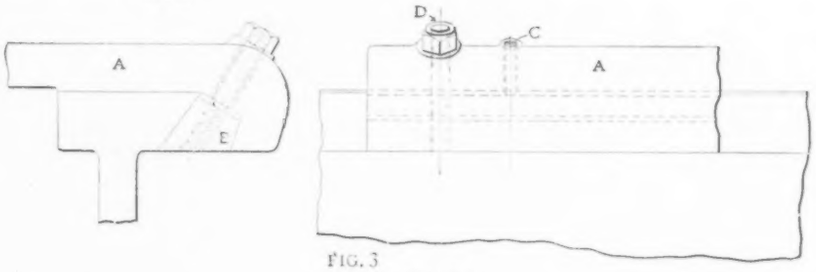


FIG. 3

LATHE DETAILS.

As regards chattering, I think that most of this is due to the small, badly-fitting centers with which most lathes are supplied. The diameters of most centers could be increased considerably without in any way weakening the spindles, and it would seem that this latter is the only point that should determine the size of the centers.

Quite a number of adjusting strips have been described, most of which have one of the two following disadvantages, viz.: either that, in adjusting, the pressure is taken on screw points, or that they do not prevent a slight lifting tendency. The strip shown in Fig. 3 seems to combine the good points of both screw-adjusted and taper gibs, and has the additional advantage of always being solid. In the figure, *A* is the body of the slide, *B* the strip, *C* and *D* are screws. Screws *C* serve to adjust for wear and screws *D* to hold the strip in position. I have not seen this strip in actual use and, so far as I am aware, the idea is new. B.

England.

Counterbore with High-Speed [Steel Blades.

Fig. 1 shows a counterbore for high-speed steel blades. The body is turned and threaded for the nut *D* which holds the adjusting screws *E*. *F* is a groove in each blade the same taper as the screw. The screws *C* hold the blades in position. If the cutters are to be ground, the taper pin *K* is driven out allowing the tit *G* to be easily removed. The blades are taken out after releasing the screws *C*. It will be understood that if at any time the blades are not all working the screws *E* will force them against the shoulder of the tit shown. Fig. 2 shows the form of the tit.

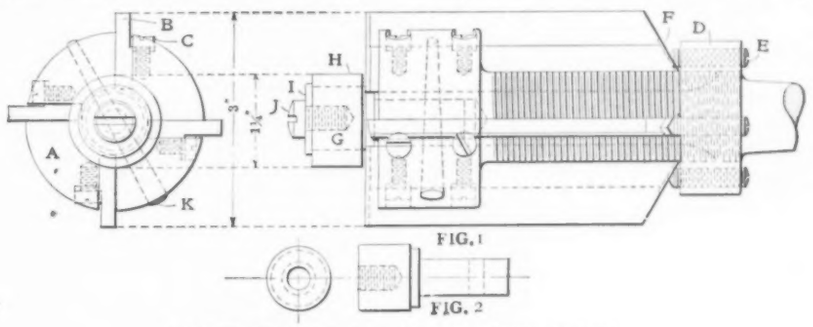


FIG. 1

FIG. 2

A COUNTERBORE WITH HIGH-SPEED STEEL BLADES.

Washers or bushings *H* can be made to suit the work. They are a running fit on the tit, thereby not liable to injure the hole in the least. The washer *J* and screw *I* secure the bushing to the tit.

I. N. QUIRE.

The Action of Lathe Spindles.

In two or three articles appearing in the AMERICAN MACHINIST lately reference has been made to the lifting of lathe spindles, and especially in that at page 301, where O. E. Simon's threading and forming tool is described. It is there suggested that the tool should be set upside down, and the lathe reversed so as to hold the spindle down in its bearing. If this works well in practice, that is better than all men's opinions, but I should not expect it to work well in practice, at least in all cases. My notion is that most small lathes have a belt pull that, at least on the large step of the cone, holds the spindle up to the top of its bearing anyway and that, with the point of the tool as a ful-

crum when the lathe is running forward, helps to keep it there. Moreover, if the lathe is run backward, and the cut holds the spindle down, there are three or four loose joints in the slide rest to jump up, where there is but one in the spindle, and the spindle is one of the easiest places at which to take up the lost motion.

In view of this consideration of the subject, while there may be cases when the belt is on the small step of the cone and the thread on the end of a long piece that the main bearing is on the bottom of the box this is exactly one of the conditions where the lathe does not chatter. When lathes are already mounted with slow forward and fast backing motion, the counter would have to be changed and this would upset the lathe for the regular work.

The cause of chatter in a lathe is not always satisfactorily explained. When a piece of leather put under a tool stops it it is hard to believe that looseness in the spindle is the cause.

JOHN E. SWEET.

Apprenticeship and Industrial Education.

I was very much interested in the article entitled, "Apprenticeship and Industrial Education," by Forrest E. Cordullo, at page 244, and I hope that this discussion of the apprenticeship problem will be heard of again in the AMERICAN MACHINIST. I have for a number of years wished that someone, who was competent to write up this phase of the question, would wake up to the fact that skilled labor in our line was and is taking a backward step, or is at least at a standstill, and I think something should be done to rectify this mistake. I have tried for the last seven or eight years to raise the apprenticeship up to a standard in our factory equal to what it used to be in my apprenticeship days twenty years ago; but it is a hard task to perform, for this reason: The young men of today seem to think that the only thing that will make men of themselves is to smoke cigarettes and drink liquor, which is the greatest drawback that can come to any young man starting out on his life's journey.

When I am looking for an apprentice to learn a trade, I first ask him, "do you smoke?" If he answers "yes," then I dismiss him. If he answers "no," then I ask him a few more questions, such as, "how far advanced are you in school? do you think you would like the machinist trade?" and so on. If he has passed through the ninth grade in a city school, or the sixth in a country school, and answers the other questions satisfactorily, I give him a trial of six months at $4.50 per week. At the end of the six months' trial, if he proves to be worthy, I give him 8½c. per hour for the next six months. At the end of the first year I give him 10c. per hour; at the end of the second year I give him 12c. per hour; and at the end of his third year I give him 25c. per hour, which is the same rate as the ordinary machinist gets throughout New England. I must say, in justice to other firms around us, that we have never lost an apprentice before his three years were completed. We find that we have the best success with our apprentices by being in close family relations with them, and by teaching them how important it is to be skilled mechanics, the first step toward being in command of other men (though it is not always the best mechanic that makes the best and most successful commander). If the proper course is followed in selecting apprentices, 99 per cent. will be successful. I believe that if an apprentice is carefully looked after he will not need to be under bonds for three or four years. I think it is a good idea to give an apprentice a bonus on the completion of his term.

As for the expense of maintaining extra supervision, my experience has been that it does not take any more supervision for apprentices than for the so-called machinists that are floating around, trying to fill positions that should be filled by competent men.

I find that the superintendents and managers are, as a rule, indifferent to the education of our skilled mechanics. I do not understand this; for I and everyone else knows that our skilled labor cannot be too well educated; furthermore, where are we to get our foremen, superintendents and managers from? for it is a well-known fact that to get the best foreman, superintendent or manager we have to go to the educated of our skilled labor.

I believe the superintendent should go among the boys and talk the educational problem over with them, so as to get them interested; show them that the company has their interest at heart and is trying to make skilled mechanics of them; get them to read mechanical papers and books, which go a long way to educate the boys. Reading teaches them to think, to rely upon themselves, and not to wait for some other fellow to go ahead and lead the way. That is one of the things that I dislike about the average boy, even after he becomes a journeyman; he seems to think that someone else should show him the way. I believe the young man should go ahead and try to accomplish something, even though he makes a mistake; for the man that never made a mistake never did anything. So I believe one of the most essential points is to teach an apprentice to rely upon himself, so that when he goes out into the world looking for a situation he can answer yes to a foreman when he asks him if he is an all-around machinist. It is impossible for me to hire an all-around machinist today, unless I steal him from some other factory; so let us get more apprentices in our factories and teach them to be skilled mechanics.

W. A. WATERMAN.

Evolution of a Forming Tool.

The sketches show the evolution of a forming tool.

Fig. 1 shows the piece to be made, the diameter *A* being never more than ¼ inch and not under ⅛ inch, the dimensions *B*, *C* and *D* being constant in all sizes of pins. *E* and *F* are alike. The dimension *A* is generally the standard size of a bessemer rod.

A circular forming tool was first made, but this proved unsatisfactory, as it was hard to hold, the least shift causing an error in the dimensions *E* and *F*. The tool was then made as shown by Fig. 2, *G* and *H* being self-hardening steel and the separator *K* machinery steel, except

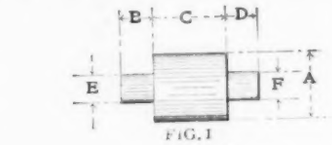


FIG. 1

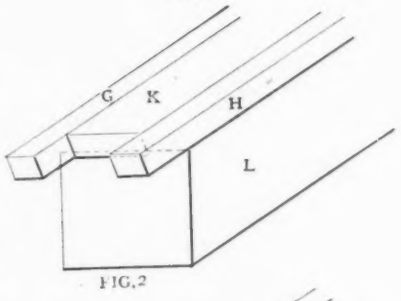


FIG. 2

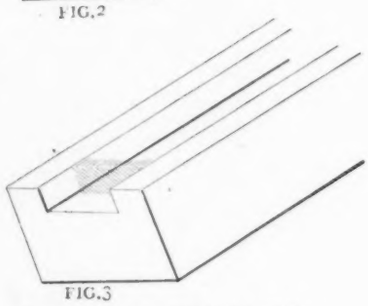


FIG. 3

EVOLUTION OF A FORMING TOOL.

where it was desired to make diameter *A*, Fig. 1, a special size, in which case the separator was made of self-hardening steel. The whole tool was mounted on a piece of machinery steel, *L*. This also proved unsatisfactory, as it was hard to hold the different members together.

The tool is now formed like Fig. 3 and proves satisfactory. It is made of tool steel equal in width to the sum of dimensions *B*, *C* and *D*, and has a groove running its entire length equal in width to *C* and ¼ inch deep. The tool is hardened and drawn from the bottom up, so that it may be used its entire length without retempering. When it is desired to make the diameter *A* a special size, a piece of self-hardening steel ground to width is inserted in the groove, as shown by the small cross-hatched portion in Fig. 3, and held in place by the screw in the toolpost. The tool, of course, is set with the cutting edge level with the center of the work.

HERMAN JONSON.

Proportioning Parts in a Series of Sizes.

The following method of procedure will be found useful in the design of such mechanical appliances as shaft bearings of various kinds, couplings, collars, and other articles of a similar nature, where it is necessary to provide for a considerable number of different sizes and where the proportioning of the various parts is largely a matter of judgment.

The sizes which are to compose the line having been decided upon, first design the smallest size and then the largest or a size close to the largest. The dimensions

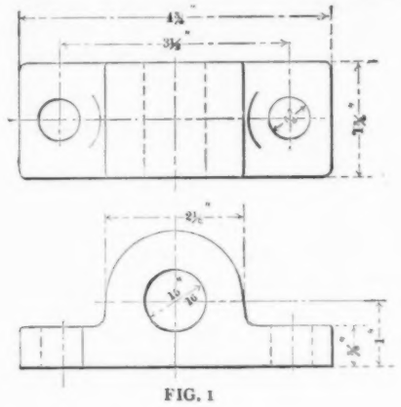


FIG. 1

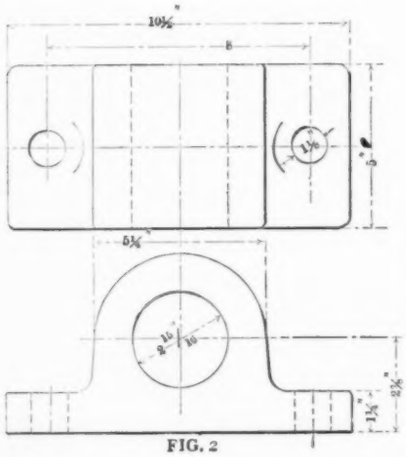


FIG. 2

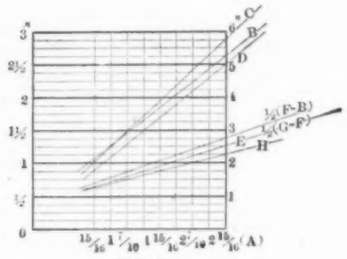
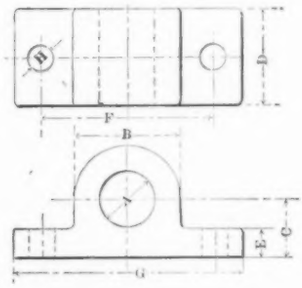


FIG. 3



A	B	C	D	E	F	G	H	$\frac{1}{2}(F-B)$	$\frac{1}{2}(G-F)$
15/16	2 1/8	1	1 3/8	3/8	3 3/8	4 1/4	3/8	11/16	3/8
1 1/16	2 1/8	1 1/4	2 1/8	3/8	4 1/4	5 3/8	3/8	3/8	3/8
1 1/16	2 3/8	1 3/8	2 3/8	3/8	4 3/8	6 1/8	3/8	3/8	3/8
1 1/16	3 1/4	1 3/4	3	3/8	5	6 3/8	3/8	3/8	3/8
1 15/16	3 3/8	1 3/8	3 3/8	3/8	5 3/4	7 3/8	3/8	1	3/8
2 1/16	4 1/8	2 1/8	3 3/4	1	6 3/8	8 3/8	3/8	1 3/8	1
2 1/16	4 3/8	2 3/8	4 1/8	1 1/8	7	9 1/4	1	1 1/4	1 1/8
2 11/16	4 3/8	2 3/8	4 3/8	1 1/8	7 3/8	9 3/8	1	1 1/4	1 1/8
2 15/16	5 1/4	2 3/8	5	1 1/4	8	10 1/4	1 1/8	1 1/8	1 1/4

FIG. 4

PROPORTIONING PARTS IN A SERIES OF SIZES.

of the intermediate sizes are then determined by a diagram in which the various dimensions are represented by the ordinates of straight lines of which the abscissas represent the series of values of that dimension which designates the sizes. The line for each dimension is located by the two particular values of that dimension taken from the large and the small size previously designed. The ordinates corresponding to the intermediate sizes then determine that particular dimension for those sizes. All the dimensions thus found may then be incorporated in a table.

An example will make this clearer. For the sake of a simple illustration suppose it is desired to get up a line of boxes, such as are shown, for shaft sizes from 15/16 inch to 2 15/16 inches inclusive. First the 15/16 inch size, Fig. 1, and the 2 15/16 inch size, Fig. 2, would each be laid out, the design and proportions being determined by the judgment of the designer. The diagram Fig. 3, is then constructed as previously explained. The letters showing to what dimension each line refers, correspond to those in Fig. 4. Part of the lines are laid off to the scale on the right side of the diagram. These are distinguished from the remaining lines, which are to the scale on the left, by being shown dot and dash. From the diagram the table, Fig. 4, is filled out.

For instance suppose it is desired to find the width D for the 1 7/16 inch size. On the diagram the intersection of the vertical line marked 1 7/16 and the inclined line D is found to be close to the horizontal line corresponding to 2½ inches on the right-hand scale. The dimension thus obtained is entered in the table.

It will be noticed that there are no lines on the diagram for dimensions F and G. A line is plotted for the distance from the center of the bolt holes to the outside of the metal around the bearing, or $\frac{1}{2}(F-B)$, and from this F is determined, the B column having previously been filled out. A line is also plotted for the distance from the center of the bolt holes to the ends of the base, or $\frac{1}{2}(G-F)$, the line in this case coinciding with the line for E. $\frac{1}{2}(G-F)$ having been obtained from the diagram, G is found from F by addition in the same way as F was previously found from B.

The reason for determining these two dimensions in this indirect manner is of course apparent. These dimensions depend partly upon B, partly upon the size of the bolts, and for that reason will not increase in a regular manner, the increase being greater whenever the size of bolt changes. In this particular as in many others judgment and discretion are of course necessary in the use of such a method.

H. S. Britt.

A Crankshaft Job.

Once when I was general machinist in a small sawmill far up in the backwoods, I got a crankshaft job which was to me rather interesting. A small steam yacht which had been portaged by its enthusiastic owners up to our part of the country, was towed by them up to the boom below the mill. The chief engineer came walking into my department—a hole in the ground under the main floor—with two portions of a double throw crankshaft in his hands. Of course he wanted me to "fix" it. After I had carefully explained that the only way to fix it was to get a new one, he became the picture of dejection, but a ray of hope sprang up as he asked me if I would make a new one. I looked at the imitation of a lathe I had and assured him that "it could not be." Anyway, I told him, it would take a long time. Whereupon he assured me that time did not matter as they could camp nearby and wait for it. I looked at the pieces he had, and what was my surprise to find them composed of gray iron. I grew interested and asked him what kind of an engine he had. He told me he burned kerosene and ran at ninety pounds pressure. I went down to the boat with him and found he had used the hammer instead of a monkey wrench whenever the opportunity offered. He told me the propeller (three-bladed, bronze) had struck a rock with the above-mentioned results to the crankshaft. The next day being Sunday I told him I would go at it in the morning and he was to be on hand as blacksmith's helper, I being naturally the blacksmith. Next morning I got hold of a 1¼-inch piece of wrought-iron shaft, and succeeded in bending it around corners until it looked like a dollar mark with out the cross lines. This was accomplished at the risk of my life, as my helper was much too strong for his job, breaking up flatter and hammer handles like kindling wood. By noon I had the object in about the same general condition as the lathe which was to turn it. I lined it up with a surface gage on a planed board, giving four inches throw to the pins, then drilled centers in the ends and roughed down the arms to 1 1/16 inches, the finished size being 1 inch. While it was on centers I took the surface gage

and scratched lines at the pin centers in both vertical and horizontal positions, then took it out and drilled the four pin centers and a 1½-inch hole through the face plate so that one arm could go through; this acted as a good driver. The tailstock of the old machine seemed to be made especially for this job and when its spindle was run way out to support the work while turning the pins there was ample clearance between the end of the crankshaft and the front of the tailstock. I finished the job at seven o'clock in the evening and by nine had it in the engine (?) with the bearings re-babbitted. I charged the chaps (there were three of them) $15 for the job and I think to this day that I earned every cent.

Canada. W. L. McL.

Hardening Dies Quickly.

At page 781, part II, Vol. 28, T. E. Heeter tells about heating dies to harden in quick time, and at the end says: "This quick heat system, of course, does not apply to coin, medallion or heavy forming dies, where your die is liable to sink and loss of correct form in figure result." I fail to see why two dies of steel from the same bar and cut off adjacent to each other need to have any different treatment in the heating, where one is used as a cutting die and the other for a coining die. It may be necessary to leave the forming die in the cooling medium for a longer time on account of the greater amount of metal to be cooled, or even in the heating the die with the most steel in it will need to stay in the oven or fire for a longer time; but if "heating steel as quickly as possible" is good for cutting dies, I contend that, bulk for bulk, it is just as good for forming dies; but if it is good for cutting dies and not good for forming dies, what kind of juggling does the piece of steel get when heated, when the cutting die and forming die are in one piece of steel as they frequently are?

In the passing of the years I have seen some bad effects caused by heating steel too quickly, and at present I know of only one shape that, under proper conditions, can safely be heated as quickly as possible, and that shape is a ring which has a circle for its cross-section, and is uniform in size. Using an oven or fire where both top and bottom will receive the same amount of heat simultaneously, it is quite safe to say that such a piece can be heated as quickly as possible, as only the outside can expand from the center, and then quite uniformly; but how often is a ring of that kind hardened? But change the cross-section into a square or rectangular form, then heat as quickly as possible under the best conditions, and see the corners get hot first; or cut the ring and have two ends, and see the ends heat up first. Shape your steel into a round die with cutting edges, or into a square or oblong die having corners as well as cutting edges; then drill in some holes (few or many, large or small) and work out some fantastic shape with some quite thick and quite thin sections, drill and tap two holes near each corner for screws for set edge and stripper, plug the screw holes with asbestos or clay, or screw in a cap screw, or leave them unplugged, then heat up your five, ten or one-hundred dollar die, as quickly as possible, and the chances are many against one you will have a two or three piece die. I have yet to see the experienced steel-worker who does not try to give his steel respectful treatment, but there seems to be no precise agreement as to what that treatment shall consist of. It is not safe to say that a piece of steel is all right after it has been hardened for the first time and remained intact. While it may have been abused by over or under-heating, this may have occurred at the best possible time and not at the critical moment, and it sometimes happens that a piece of good steel will stand a little abuse at the first hardening.

The real test of a piece of steel that has been hardened, and at the same time abused, is to repeat the process, not once, but several times, and note the results. Under the action of heat carbon steel is very sensitive stuff, and if a piece is heated as quickly as possible the corners and thin parts are very apt to be overheated or heated faster than the heavier parts; this will cause unequal strain, and if this takes place at the wrong time the one who does the heating may look for a crack, and usually finding one, will blame the piece for cracking in the water or on the descending heat, while the probabilities are the crack started on the ascending heat and was caused by unequal strains due to unequal heating. If someone would invent some means whereby a piece of steel could be uniformly heated throughout, the process would be of untold value; and if that were followed by a process by which the piece could be uniformly cooled, the troubles of the steel hardener would be at an end; but it is very doubtful if the interior of a piece of steel will be heated only by conduction.

It may not be out of place for me to state my rule for heating carbon steel, which is: Heat rapidly but uniformly, and don't try to get a uniform heat in a two by three fire, whether heating for forging or hardening purposes. However, I have seen tools too long for the fire at hand, where it was necessary to pull the steel back and forth in order to get the necessary heat, and to all appearances the hardening was all that could be desired; but I am of the opinion that the center by reason of having the long heat, while the ends were getting hot, was having its carbon dried out, and the surfaces and cutting-edges were slightly decarbonized, and although it might never show on the job, it might wear out a grindstone or emery wheel keeping it sharp, and no one guess the real cause. G. SCHNEIDER.

Packing Goods for Foreign Shipment.

Referring to your editorial remarks at page 166 about the apparent insufficiency of export packing, it is usual with some of the large English shippers to pay four-fifths of the freight three days after the departure of the vessel, the usual documents and mate's receipt having been signed. The one-fifth is retained pending notification of receipt of goods without damage. This arrangement has proved to work well, and thus the ship is made in part responsible for careless handling. A vessel under the conditions of British shipping gets clear papers on discharge if the cases are not damaged externally and show no signs of injury. As a consequence the ship's carpenter spends many a long day in port making good damage in dark corners of the hold or 'tween decks, so that the ship shall not suffer. Some one suffers, of course; and in the case of large export houses a properly accredited agent to see shipment and discharge would earn a good salary or liberal commission. There are two courses open to shippers under present conditions: 1st, to make the cases so strong that it shall be a moral certainty that no damage can result, *the shippers taking the risk;* 2d, to make the cases light, so that any undue handling shall show its marks. And under special conditions of freight as above *make the ship responsible for all damage.*

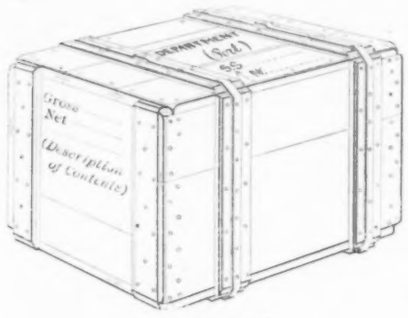
Parts of Each Case.	Net Weight of Contents.				
	Not Exceeding 1 cwt.	From 1 to 3 cwt.	From 3 to 5 cwt.	From 5 to 10 cwt.	From 10 to 15 cwt.
Sides	¾	1	1¼	1¼	1½
Ends	1	1	1¼	1½	2
Tops and bottoms	¾	¾	1	1¼	1¼
Battens for cases under 5 ft. in length	3 × ⅝	4⅛ × ⅝	5⅛ × ¾	5⅛ × 1	7 × 1
Battens for cases over 5 ft. in length	4½ × ⅝	5½ × ⅝	5⅛ × ¾	7 × 1	7 × 1
*Hooping	⅞ × 21 S. W. G.		1¼ × 18 S. W. G.		
Wrought clout nails for hooping	1	1	1	1¼	1¼
Wire nails for sides and ends	2½	3	3	4	4
" for top and bottom	2	2½	3	3½	4

* Hooping is required for the cases (unless this line is struck out).

THICKNESS, SCANTLING, ETC., REQUIRED, IN INCHES.

The report of the special agent at Tientsin is of interest to me as, when discharging at the Yalu for that place, the method of discharging I noticed was capable of improvement.

I don't know the depth of water over the bar, but only vessels of light draft can get up to the town and put the goods on the quay. The majority of cargo for Tientsin is transshipped to lighters, and the fact that the Chinese there are the



PACKING CASE.

most powerful Asiatics that I saw on the China coast may be a contributory cause to the matter of the special agent's report.

A specification for cases used by the Indian Government for shipments from England, and which has given every satisfaction over a number of years, provides among other things for cross railing through the battens. The specification follows. CENTRODE.

London, England.

PACKING CASE SPECIFICATIONS.

The packing cases are to be made of sound, well-seasoned white deal boarding, free from all defects.

They are to be battened as shown in sketch below, unless the length of the case exceeds 6 feet, in which case three or more sets of battens are to be used instead of two, as shown in the sketch. All battens are to be chamfered on the exposed edges, and all corners are to be taken off.

The ends of the sides are to be flush with the outside faces of the end battens, and nailed to them as well as to the ends. The nails used for fixing the battens are to be of sufficient length to allow of clinching on the inside of the case; those used for the hooping are not to be more than 5 inches apart.

All joints are to be tongued and grooved.

A Standard Size for Business Cards.

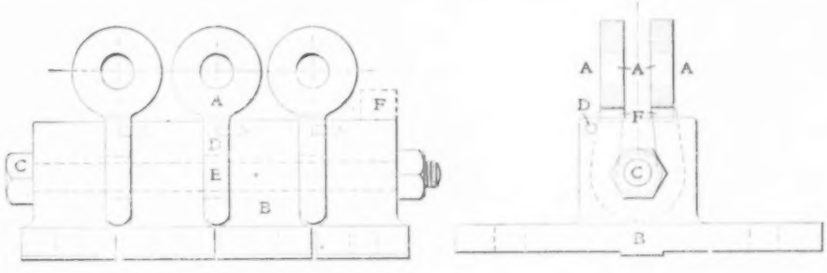
Mr. Osborne's suggestions about business cards at page 260 recalls my experience along the same line. For the past 14 years I have had occasion to meet a good many men who might wish to buy machine tools. At the very first I had some dinkey little cards gotten up in nice shape. I soon discovered that the name of my firm was totally unknown, and that this fact together with the card's telling what my line was, kept me out of a good many places that I would at least have liked to see. So I forgot to carry along my cards the rest of that trip and when I struck a shop I would say to the office boy "my name is Entropy, from Toolville, and I would like to see Mr. So-and-so." I could tell the boy if he looked blank that I had left my cards at home. Everybody bit at it like hot cakes. Nobody had ever heard of me before, but Toolville is quite an important point and they all appeared to be afraid that I might be some important personage whose name had escaped their notice. At any rate I never have been refused the audience that I sought. I still keep one of these old cards so that I can refer to its being at home if necessary, but I haven't had any more printed.

Carrying out Mr. Osborne's suggestions a trifle further I would suggest that it might be a paying investment for a firm to send out a card 3x5 inches with the name of the firm at the top in good black type and under it an alphabetical list of the goods made with provision for a record of quotations made so that the recipient could readily file it as a complete record. The use of these filing trays is so common now that very few such cards would ever get to the waste basket if they had the slightest possible future value.

ENTROPY.

A Fixture for Milling Shackles.

The fixture here shown was devised by our foreman for milling shackles, in quantities, on the four faces *A*. As these required to be a fairly accurate job we used a gang of 3 cutters, one on each side, and one in the center the width of the finished slot. The fixture is composed of



FIXTURE FOR MILLING SHACKLES.

a series of gray-iron brackets, *B*, planed on the bottom to fit the milling-machine table and held down by two ⅝ bolts and nuts in the slots. *C* is a long ¾-inch bolt for holding the parts together while the work is being done. Before this bolt is tightened the bolts holding the brackets to the table should be slackened to allow them to be drawn tight up to the shackles, which are stampings and fairly uniform in size. 5/16-inch round steel pins *D* are driven tight into the brackets to set the work against. At *E* are pieces of tubing for filling up the spaces around the bolt *C* in the shackles, to prevent them from moving when tightening up. Two pieces, *F*, of mild steel dovetailed into brackets *B* act as gages for spacing the cutters when setting them on the arbor. When very large quantities are to be milled six shackles should be gripped at once; this requires seven brackets, the two end ones being somewhat wider than those in the middle. With two sets of fixtures, one at each end of the table, the operator can set one lot up while the other six are being milled. With this fixture a boy can mill per day 250 shackles having a face about 1¼ inches in diameter. SOEZE.

England.

A Drawing Board for Patent Office Drawings.

The transparent drawing board, illustrated and described at page 325 and signed by B. R. Judd, is my invention on which I am making an application for a patent. B. R. Judd is employed by the same firm as I am and sent the description to you without my consent or knowledge, in which he has done me an injury, as it would invalidate my foreign patent if the publication reached the foreign country before my application.

Kindly inform your readers that this board as shown in your publication is not public property. PAUL A. KAEPPEL.

Currency Reform.

Moody's Magazine for March contains, among other notable articles, one by Lyman J. Gage, former Secretary of the Treasury and at present the president of the United States Trust Company. Mr. Gage deals with the nature of currency and of credit, pointing out the fact that in these days, a relatively small proportion of the business transacted is transacted by the use of money, but that it is done mostly on a basis of credit or of commercial paper of various kinds, such as promissory notes, bills of exchange, drafts, checks, book accounts, etc., these all being made effective through the office and function of the bank. The article is designed to point the way to currency reform, and ought to be read by all who are interested in that important subject.

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The Fight Against the Meter.

The facility with which people who are constitutionally or otherwise opposed to a change of any kind find plausible arguments for letting things remain as they are is well illustrated by some of the arguments which are being presented in Philadelphia and elsewhere against the introduction of water meters. The *Philadelphia Enquirer*, for instance, says: "Major Gilette's plan of putting meters in every house is as old as the hills. It has frequently come before councils and as frequently has been bowled out. For what does the idea mean? That the people are asked to go down into their pockets and pay for the erection of a barrier against the use of water. It means restriction."

Now, that sounds very well when read rapidly; but of course the fact is that nearly everything has to be as old as the hills before your true conservative will adopt it, and nearly every new proposition will be "bowled out" repeatedly before it is finally accepted; the fact that a city council bowls a thing out being absolutely no evidence that the thing itself is without merit. And now comes the *New York Medical Journal* with an argument against the water meter. It first presents what it calls an "economic argument," which, however, is too weak to require notice, and is contradicted by all experience. The balance of its argument, bearing upon the use of water in relation to health, seems to be based upon the assumption that, with the meter, water consumers will be required to pay for the water they use, whereas now they in some way escape such payment. Of course, nothing could be more absurd. When meters are not used, water consumers pay not only for the water they use but also for the water they waste, and those who are more careful or more considerate, and who waste little or no water, are still charged rates for the use of water, which rates are based upon the fact that most people do waste water which has to be paid for, and the innocent and careful therefore suffer for those who are not so innocent and not so careful.

Experience in cities where meters have been used has already upset all the arguments that have been brought against their use; but it seems necessary to go over and refute again all these arguments in every city where it is proposed to introduce meters. It has happened in numerous cases where the necessity for the enlargement of a city water works has presented itself, that, by the introduction of meters, such enlargement was made unnecessary, and yet every citizen had all the water he really wanted for actual use; the meters having only the effect of stopping waste. With meters a smaller water department has to be built and maintained by water consumers than is needed where no meters are used, and this means that water consumers pay less for the water they need. But with meters the careless householder cannot afford to allow water faucets to leak continuously, nor can he afford to allow a stream of water to continuously run away for the purpose of having a cool drink occasionally, or of preventing the freezing up of water pipes. There are better ways of accomplishing these results, even for him, and the water meter simply induces him to search for and apply these other means, while himself and neighbors are spared the inordinate expense of paying for the water which he would otherwise waste.

The water meter is based upon the perfectly sound economic and commercial proposition that the consumer should pay a fair price for that which he receives, and should pay in proportion to the quantity received, and the practice of simply allowing a householder to use and waste all the water he pleases for a year, at a given gross charge, is as absurd as it would be to allow him to use all the gas or electric current he might choose to employ or waste upon the same terms, or even to supply him with coal and groceries in the same way. Suppose a coal dealer should undertake to supply a family with coal for a year for a lump sum and place no limit upon the amount to be supplied. Does any sane person think the coal bill of that family would thereby be reduced? The meter will eventually be regarded, of course, as a necessary part of a waterworks system; but it is somewhat discouraging to hear the silly arguments against it that have been so often presented, and as often refuted, and repeatedly disproved by actual experience.

Simplified English.

Those who believe in simplified spelling for English words—in the elimination of unnecessary frills in spelling, which frills are analogous to the ornamental features formerly made a part of machine-tool designs, will be glad to know that a strong organization has been formed in New York to advance the cause of simplified English spelling. The new body is called the Simplified Spelling Board. It is composed of prominent educators, editors, publishers, and men of affairs, while the expense of the campaign it is to carry on is to be borne by Andrew Carnegie, who has interested himself in the movement. The effort to be made is based upon the belief that the English language may be the world language of the future, but that, in order to facilitate this, the inconsistencies and curiosities of its spelling should be eliminated, and that there should be a more rapid advance toward phonetic spelling, which of course, has been and is constantly taking place, but not at a rate sufficiently rapid to satisfy those who would prefer to see within their own lifetime some perceptible improvements. Simplified forms of

spelling have been approved for a goodly number of words, so that those who wish to (and can) progress along that line will be backed up by the highest authority.

Jokes with Compressed Air.

Press despatches contain an account of the death of a boy employed in the works of the Cambria Company, at Johnstown, Penn., whose death was brought about by means of compressed air injected into his viscera by a workman who was in a playful mood. This is the second so-called accident of that nature which has come to our notice, the previous one occurring, we believe, in Paterson, N. J. It is high time, it seems to us, that those who have to do with compressed air should know that it is a thing not to be trifled with. We have a letter from an employer in whose shop compressed air is used, and he expresses it as his opinion that those who attempt practical jokes with compressed air should be severely dealt with. In his own shop, all employees are warned as to the danger of attempting to play any practical jokes with compressed air, and he believes that something of the kind should be done in every establishment in which it is used.

Cheating Scales.

No doubt many of our readers have seen and admired the ingenuity and convenience of the various styles of computing scales which are coming into use by retailers, and especially by butchers, and which scales indicate not only the weight of the thing sold, but also its price at any desired rate per pound. Probably most people consider these scales to be a protection to the buyer, because they obviate the liability of mistakes in computing the lump sum to be paid for, say 3 lb. 7 oz. of beefsteak; but it seems that at least some of the makers of such scales have gotten themselves into trouble by making a scale designed to favor the retailer by not less than 3 per cent., this being done by always giving the fraction of a cent to the dealer. A circular has actually been sent out by the manufacturer of this scale to retail butchers, calling their attention to the fact that in ordinary business one of these scales will be paid for in about six months' time by the amount thus "saved"—and which, of course, is taken from the pockets of customers. The scheme has been revealed by a rival manufacturer, who first sent a circular letter to butchers calling attention to the fraudulent character of the scales they were using. This produced no visible effect; but when a circular was sent to the customers of the retail butchers, then very perceptible effects were produced, and the maker of the fraudulent scales at once instituted suit to prevent injury to his business. The courts have just decided against him, and the distribution of the enlightening circulars will therefore presumably go on; which of course is a very good thing. Computing scales honestly made are a very useful thing; but where they are not used, a table similar to those we are constantly printing in our columns, and having various weights advancing by ounces down one side of the table, and various prices per pound across the top of it, while at the intersections of the vertical and horizontal columns are placed figures representing the amount to be paid for the given weight at the given price, will answer every purpose and can, of course, be readily checked up. Such a table posted alongside the scales will enable calculations to be made rapidly; though, of course, the computing scale, properly made and used, is better. Evil-disposed men can do all the cheating there is any demand for. We object to machines of any kind being made to facilitate the operation.

The "United States Trade Reports" Fraud.

The editor of the *United States Trade Reports* of Cincinnati, Ohio, has had the cheek to send one of his proposed editorials to the Worcester Loom Company, and with it a letter containing the usual suggestion that when this hot-air editorial is published, an order for copies of the utterly worthless and fraudulent journal referred to will be in order, and will be appreciated. The president of the company referred to remarks in his letter to us that "our machinery does not go to 'all parts of the country,' and their description proves that they know nothing about what they are writing of." This, of course, is nothing new. It has been repeatedly demonstrated that there is no one connected with the *United States Trade Reports* who knows anything of mechanical matters, and the mistakes they make, taken in connection with their claims of a thorough investigation by a staff of experts, are simply ludicrous. We wonder how such a journal gets the use of the United States mails.

In this issue Charles T. Porter resumes his delightful personal reminiscences connected with the important work he did a generation ago in the introduction and popularization of high-speed steam engines here and abroad.

There has been a long interruption of these reminiscences, due to an accident which occurred to Mr. Porter, and which made it seem, for a time, as though there could be no further publication of them. Now, happily, Mr. Porter's health has been restored, and we shall hope to see him complete his reminiscences, and can assure our readers that he has in mind many very interesting things to present.

New Publications.

"Electric Power Transmission." By Lewis Bell. Fourth edition, 721 6 by 9 inch pages, with 341 illustrations. The McGraw Publishing Company, New York. Price, $4.

The appearance of the fourth edition of so voluminous a work as this is sufficient evidence that it has met a real need. The object of the book as explained in the preface to its first edition is to set forth in the simplest possible manner the fundamental facts concerning present practice in electrical power transmission. As an indication of the changes that have come over electrical construction since the appearance of the first edition, the author says in his preface to this edition: "It has now become a hopeless task to keep track of 10,000-volt plants, which are at present utterly commonplace, so that in retaining merely as a matter of general interest a list of high voltage transmission plants nothing under 20,000 volts is included." The book is very largely descriptive, and not at all mathematical. It explains the leading facts regarding the actions of various types of electrical machinery, but does not attempt to explain the calculations connected therewith. It is very comprehensive, and discusses engines, water wheels, and hydraulic development, together with steam turbines as an essential part of an electrical generating station.

"A Few Points on Grinding," by Chas. H. Norton. 28 3½x6-inch pages. The Norton Grinding Company, Worcester, Mass.

This pamphlet contains a large amount of valuable experience, condensed in very small space. It relates to grinding wheels, steady rests, chatter, speed of work, traverse of work and truing the wheels. It is we judge published for gratuitous distribution and it should be in the hands of all users of grinding machines, and the many who ought to use them but do not.

"The Business of Contracting." By Ernest McCullough. 45 5x7½-inch pages. The Technical Book Agency, Chicago. Price, 50 cents.

In a very brief and practical manner the author of this pamphlet discusses the organization, working, office and field methods of the modern contractor. Hints on bidding and the management of men are also discussed, and we judge that the problem of many machine-shop managers is also the problem of others, for we find the statement that "good foremen are nearly as scarce as the proverbial hen's teeth."

A Pittsburg paper announces the running of the first heat in the foundry of the Carnegie Technical Institute. This was done by students and was pronounced by Superintendent Fuller, the instructor, to be a complete success.

New Tools and Machine Shop Appliances.

A MOTOR-DRIVEN DOUBLE-SPINDLE LATHE.

The double-spindle lathe made by J. J. McCabe, 14 Dey street, New York, can now be had with motor drive. The motor is a 7-h.p. variable speed, direct-current machine. It has a range, through 20 gradations, from 350 to 1750 r.p.m.; is mounted on brackets secured to the headstock and drives the lower spindle through gears. The controller is placed on the floor in front of the headstock. The spindle of the controller is geared to a splined shaft running along the bed, and operated by a crank with index pointer and dial connected to the lathe carriage, from which point it may be started, stopped, reversed or the speed may be varied. A circuit breaker, of the double-pole independently operated type, mounted on a slate slab, is conveniently placed in front of the motor.

A NEW LINE OF SMALL MOTORS.

The Westinghouse Electric and Manufacturing Company has brought out a line of small motors ranging from 1/20 to ⅛ horse-power for driving sewing machines, dental apparatus, phonographs, etc. They are made for both alternating and direct-current circuits, the voltage being either 115 or 230 and the cycles of the alternating machines 25, 60 or 133.

THE "SIMPLEX" FILING CHART.

A filing chart which should be of interest to those having to do with the filing of drawings, catalogs, correspondence, etc., has been devised by C. Schmidt, 46 Ridge street, New York City. The chart is known as the "Simplex" and is ruled off in half-inch squares, these being arranged in 26 rows of 26 squares each, with the letters of the alphabet running across the sheet at top and bottom and down each side. The squares are numbered in order from left to right, the numbers thus ranging from 1 to 676 inclusive. In numbering papers for filing, the first letter of the name is found in the alphabet at the left and the line followed to the right until the square is reached which is under the second letter of the name. The number in that square is the key number. By referring to the alphabet at the top and finding the number of the third letter in the name a combination number is obtained; thus in "Schmidt" the letters *S* and *C* will give the key number 471 while *H* will give the number 8, the combination thus being 471-8. The papers so numbered may be arranged numerically in guide cards or folders for the filing case. If the first name of the group should be Adams, the folder would be marked "*AD-A*. 4-1". Where there are several names as Adams, Adamison, Adamite, etc., for the same symbol, the material is simply placed in alphabetical order under *AD-A*.

COMBINATION CENTER REAMER AND COUNTERSINK.

The line cut, Fig. 1, illustrates a combination center reamer and countersink, which is especially adapted for use in centering machines where a separate drill is used for the tit center. In Fig. 2, which is a section through a piece of work, showing the lathe center in position, the countersink around the center is plainly shown; this gives the shaft a finished appearance and protects the center from injury; also affords a saving in time in facing the ends of shafts, as it is not necessary to face right up to the lathe center. Two sizes are at present made, having countersink diameters of ⅝ inch and ¾ inch, the shanks being ½ inch diameter. All centers are accurately ground to 60 degrees angle. This tool is made by G. R. Lang Company, Cincinnati, Ohio.

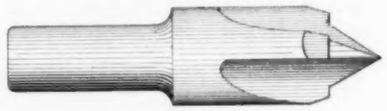

FIG. 1

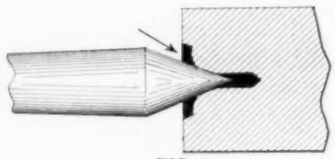

FIG. 2
NEW CENTER REAMER.

A COMBINATION TOOL.

The Detroit Tool Company is putting on the market a combination tool which on one base includes the following tools: An anvil, a pipe vise, a forge, a bench vise, a drill press and an emery wheel. This tool is 50 inches long, 10 inches high and 12 inches wide; it weighs 200 pounds and is intended for automobile repairs and small job shops.

A COMBINATION FURNACE.

A combination furnace has recently been brought out, having on one base, three gas furnaces for various purposes. On the left is the muffle section. In this section the flame is projected from the double burners into the chamber encircling the muffle. The lining is so constructed that a rotary motion is imparted to the flame, causing the heat to be distributed evenly over the enclosed space. The products of combustion are drawn off through two small openings at the top of the chamber. The work does not come in contact with the products of combustion, which is desirable when heating dies, milling cutters and other expensive tools.

In the forge section, which is to the right, two burners project the flame into the combustion chamber, which is circular in form. The lining is so shaped as to impart a rotary motion to the flame, which distributes the heat evenly thoughout the chamber. This forge is convenient for dressing and hardening small forgings and tools.

The combustion chamber of the crucible section is in the center, it is circular in form, and the burners are so arranged as to project the flame into the chamber without striking the crucible directly. As a result, a rapid centrifugal motion is imparted which distributes the heat evenly. A vent in the rear allows the products of combustion to pass off. This furnace is well adapted for lead hardening. The lead bath may be kept at a uniform temperature for an indefinite period with a minimum consumption of gas. For tempering, a crucible similar to that for the lead bath may be filled with tempering oil and a thermometer suspended in the bath enables the exact heat to be maintained for tempering and drawing the work properly. The furnace is made by the Chicago Flexible Shaft Company, Chicago, Ill.

A FOOT-POWER CORE-CONING MACHINE.

A foot-power core-coning machine has recently been put on the market. This machine is a handy accessory where core machines are employed for making stock cores. Owing to the fact that core rooms are usually without power the foot-power drive is chosen. The ends of the cores are coned by means of an emery wheel 8 inches diameter by 1¼-inch face, the sides of the wheel being used for this purpose. Gages are supplied with which a uniform taper of 3/16 inch per inch of length is obtained. The capacity of the machine is for cores fom ⅜ to 2½ inches diameter. It is made by the Falls Rivet and Machine Company, Cuyahoga Falls, Ohio.

A. S. M. E. Meetings.

The last monthly reunion of the A. S. M. E. for this season will be held at the house of the society in New York, the evening of March 27, when C. J. H. Woodbury will present a paper on "The Mechanical Engineering of Telephone Systems." It is also announced that the spring meeting to be held at Chattanooga will take place May 1 to 4, and that a very attractive program has been arranged.

In a table giving the number and gross tonnage of new vessels, taken from Lloyd's Register of British and Foreign Shipping during 1905, we note that while the United Kingdom had 576 steel steamships, with a gross tonnage of 1,197,033, the vessels of corresponding class registered from the United States footed up to the immense total of one, of 20,714 tons.

A manufactory at Arques-la-Bataille, France, is having much success in making silk from wood pulp. Here is another industry to help the carpenter, the joiner and the paper-maker to use up the forests.

Arithmetic Computations—Methods of Performing and Checking—Casting Out Nines.

BY JOHN G. D. MACK.

In all arithmetic computation, the most essential feature is accuracy. The required accuracy may be divided into two distinct classes: First, absolute accuracy to the last figure as required in various forms of financial calculation; second, accuracy of a certain number of significant figures as required in engineering computations, such as problems involving the strength of materials, horse-power of an engine, etc.

The necessity for exact results in most forms of financial calculation needs no demonstration.

In making interest computations, the three elements, principal, time and rate are accurate to the last figure; hence the calculation must be carried far enough to insure the accuracy of the third decimal which fixes the cents or second decimal.

Cases frequently arise in financial calculation in which a smaller number of significant figures is used, as for example in the determination of present values by taking a per cent. of the new value. This "per cent. condition" is usually a matter of judgment, hence not mathematically accurate. A common method of making this approximation is to give no decimals (cents) in the final value of the item, adding another dollar if the cents value is above $0.50, and dropping the cents from the result if below this amount. If the cents is even fifty, one dollar is added if the dollars amount is odd, and dropped if even. This balances approximately when applied to a number of items, saves two columns of figures, and is entirely within the limits of accuracy of the data.

As an illustration of calculations of second class, suppose a beam is to be designed for a given load. If no tests of the material are at hand, a fair average value is selected, and a factor of safety used depending on the conditions of service and kind of material. Assume that the ultimate strength divided by the factor gives a working strength of 12,000 pounds per inch, which value is to be used in the design of the beam.

We have then two approximations in the data—the ultimate strength and the factor of safety, assuming mathematical accuracy of beam formulas. Even though it had been possible to test the material, no two specimens would have shown exactly the same value, and the chances are infinite against even one showing precisely 72,000 pounds. Thus it would be a waste of time to carry through the calculation longer numbers than would give significant figures in the result more than one in excess of the section modulus values as shown in the beam tables. For example, a Cambria 10-inch 25-pound I beam has a section modulus of 24.4 and a 10-inch 30-pound, a modulus of 26.8, no intermediate size being listed.

If the trial calculation be carried out to 25.37891, it does not imply greater accuracy, for the data, as shown above, do not warrant so many figures, but indicate only a waste of time on the part of the computer. For the same reason, the horse-power of an engine carried to a number of decimal places does not show accuracy of the test, for the diameter and stroke are certainly not accurate to 0.001-inch. There are sources of error in the indicator, planimeter, and revolutions as well which limit the number of reliable figures in the result.

There is a tendency to condemn the slide rule on account of the small number of figures which it indicates, it sometimes being termed a "guess stick." The 10-inch rule, if correctly set, reads the first two figures from the left correctly, and the third should not vary more than one unit from the correct value. Before making the condemnation just referred to, one should be certain that the data are accurate to a greater number of significant figures than can be read on the rule. There may be exceptions to the statements made above caused by arbitrary conditions. For example, in certain forms of specifications used by the Government, as little as possible is left to the discretion of the designer. If 12,000 pounds is the assigned limit of stress and a certain section shows 12,100, which no designer would hesitate to use, another section must be selected or the distribution of stress changed.

A prominent bridge engineer once said to me, "In most of the design calculations for which I am responsible, the slide rule gives sufficient accuracy, but when working to exact specifications (of the kind noted above), logarithms or long arithmetic methods are used."

It may be stated as a general principle, that the number of significant figures which should appear in a result is controlled by the accuracy of the data involved, unless the calculations are governed by arbitrary specifications; but the point to be noted is that a large number of figures in a result in engineering calculations does not necessarily imply corresponding accuracy.

To give a result in a number of figures greatly beyond the reliable figures of the data, is like taking the dimensions of saw logs or paving blocks with a micrometer reading to 1/10000 inch. In order to make use of certain methods of checking arithmetic work, the results must be carried out in full, the reliable figures being dropped afterward.

METHODS OF CHECKING.

Arithmetic work should always be checked. This checking if possible, should be by one other than the person who performed the operation, for the chances are very great against two persons using false reason, or making a slip of memory at the same point, and thus making the same error in the result. If they differ in results, the operation should be repeated independently until agreement is reached.

When the conditions of the problem admit, the result should be studied to see if it is "reasonable." In using the slide rule a knowledge of a method for locating the decimal point is very desirable, but ninty-nine out of one hundred problems can be pointed correctly by the above principle. For example, if a tie rod area reads 237, a moment's thought will convince one whether it is 23.7 0.237 or 2.37 inches. This applies with equal force to other engineering problems.

Addition. The most laborious of all arithmetic operations to one who is not an expert, is addition of long columns. Sometimes the column can be divided into sections which are added and checked separately and the sub-totals then added together. The old rule for checking addition, namely, add in reverse order, is the most satisfactory. Casting out nines described below can be applied to addition, but requires a greater amount of numerical work than reverse addition and is but a partial check.

Long practice in addition, multiplication and other arithmetic computations make those who have the gift for this work almost infallible, but this does not usually apply to the person who does not make a business of computing. To meet this defect, as well as to increase the speed of computation, a number of machines have been placed on the market. Of these machines the adding machines are the best known and in the most general use. They are of two types, dial reading, and printing, though the two types are sometimes combined. With the dial adder, the only check is that given for written addition, namely, add a second time, the reverse order not being so important as with written addition.

The printing adder, in which the separate items are printed on a strip and the sum below, does not insure accuracy in itself, for a number may be shifted one or more places or its digits transposed. The printed slip should be compared with copy item by item, preferably by reading aloud from strip to a second person who follows copy. As it is generally not possible to use a reader, the operator usually makes the comparison, but this method is not a safe insurance against error.

Subtraction is the least laborious of the four primary operations and can best be checked by adding the remainder and subtrahend, the sum of which must equal the minuend to check.

"Casting out nines" has the same application to subtraction that it has to add-

ition, and is of no practical value in this operation.

Some machines will also perform subtraction, but as the operation of subtraction is not laborious, the machines are of less importance in its consideration.

Multiplication, particularly of long numbers, is a tedious process involving as it does both multiplication and addition.

Multiplication can be performed on some of the multiple bank key machines by a successive addition process, but the result is not easy to check except by repetition.

Written arithmetic work can be partially checked by the process long known as "Casting out Nines" to which several writers have referred recently in the AMERICAN MACHINIST, but this method is of less importance in checking addition and subtraction than in checking multiplication and division.

CASTING OUT NINES.

This check can be applied in a few seconds to either multiplication or division when the operations are performed in full by the ordinary arithmetic processes. It is a partial instead of a complete check for the reason that it will show a false check if the result is in error by 9 or a multiple of 9. The chance for error in the original work should be small, and this combined with the fact that the error must be 9 or its multiple to show a false check, if the latter is applied correctly, reduces the chances for final error very materially.

If the result contains an error which on being divided by 9 leaves remainder x, the only way a false check can appear is by an error of x in the checking process, a condition against which there are a number of chances, one of which is the simplicity of the checking process and the consequent small chance for error in its application.

One of the frequent sources of error in copying numbers is the transposition of a pair of adjacent digits. This is not likely to occur, however, in the ordinary operations of arithmetic, as the figures are usually written one at a time. Casting out nines will not check this error if it occurs, for this belongs to one of the exceptions already noted, the difference between two numbers having the same figures arranged in any different order always being 9 or its multiple. Thus:

	8357	8357	8357	8357
Transposed digits....	8375	3857	7538	3758
Difference	18	4500	819	4599

All of the differences are multiples of nine which will be true for transposition in the upper numbers as well. While the method of checking by casting out nines is not a positive check, it will be seen that the chances are very much in favor of accuracy if a check appears. On the other hand, if a check is not shown the computer knows that something is certainly wrong, either in the primary operation or in the checking and repeats the work.

The principle of the "Casting out Nines" check is as follows, shorter methods being shown later:

$$\therefore 74 \times 84 = \{(8 \times 9) + 2\} \times \{(9 \times 9) + 3\} = 6216.$$

By algebraic multiplication similar to $(a+b) \times (c+d)$ the expanded portion of of the above equation is equal to the sum of three multiples of 9 plus 3 times 2, the same remainder obtained on dividing 6216 by 9, or 6.

Applied to multiplication, the method consists of the comparison of the product of the remainders left on dividing multiplier and multiplicand each by 9 with the remainder from their product on dividing it by 9.

Thus—	74	remainder 2
	84	remainder 3
	296	product 6
	592	
	6216	remainder 6 (check)

If the product of the remainders from the multiplier and multiplicand is greater than 9, divide it by 9 and use remainder so obtained for comparison.

Thus (R equals remainder on dividing by 9).

77	.....	$R=5$
76	.....	$R=4$
462	Product	20....$R=2$
539		
5852	.....	$R=2$ (check)

If one of the numbers is divisible by 9, the product of the two numbers is known to be a multiple of 9 and no preliminary multiplication of remainders is required.

Another digit, as 8 or 7, could be used, but with 9 the process can be materially shortened on account of the following curious property of numbers: The remainder on dividing a number by 9 is the same as that obtained by dividing the sum of its digits by 9.

Thus 278,431 divided by 9 gives a remainder of 7. The sum of the digits is 25, which on being divided by 9 gives a remainder of 7, also obtained by adding 2 and 5. If the sum of the digits is less than 9, that sum is the remainder, thus 13,121, $R=8$.

This property of numbers is thus explained:

$$\begin{aligned} 723 &= (10 \times 72) + 3 = (9 \times 72) + 72 + 3 \\ &= (9 \times 72) + (10 \times 7) + 2 + 3 \\ &= (9 \times 72) + (9 \times 7) + 7 + 2 + 3; \end{aligned}$$

that is, a certain multiple of 9 plus the sum of the digits.

This method of adding the digits should always be used instead of dividing by 9, and can often be shortened by cancellation. For example, using the number above, 278,431, it can be noted at a glance that $7+2=9$ and $8+1=9$, leaving $4+3=7$, the remainder.

Checking by use of cancellation applied to a long problem is as follows, omitting partial products which were used in the multiplication.

278432 ..	$R=8$
64817 .. 17,	$R=8$ product 64, sum 10, $R=1$.
18047126944 .. 10,	$R=1$ (check).

This check was applied to this example in 30 seconds, using cancellation and addition of digits. In the multiplicand all digits cancelled but the 8. The multiplier after cancellation had 6, 4, and 7 remaining and the product but 4 and 6.

In division without remainder the process of casting out nines is applied as in multiplication, for the product of quotient and divisor is equal to the dividend.

Thus giving full mental process:

$$\begin{array}{r|l} (77) & 5852 \\ \hline & 76 \end{array}$$

Adding divisor digits $7+7=14$, $R=5$.
Adding quotient digits $7+6=13$, $R=4$.
Product of R's $=20$ (adding $2+0$, or dividing by 9) check figure 2.
Sum of dividend digits 20, $R=2$ (check).

In division with final remainder, as $2497 \div 71 = 35$, with remainder 12, proceed as above with divisor and quotient to obtain check figure; thus, 71....$R=8$; 35....$R=8$; product 64; check figure 1. Subtract remainder R from divided R and compare with check figure, thus: remainder (12), $R=3$, dividend (2497), $R=4$; subtracting, $4-3=1$ (check). If the dividend $R=O$, or less than remainder R, add 9 to former, and make subtraction as just shown. If the final remainder is divisible by 9, the method is applied as for division without remainder.

American Machinery for China.

The latest news from China of interest to the engineering world is that the Imperial Government purposes establishing an industrial and commercial museum in Pekin, and further that the necessary site has already been obtained. It is intended to establish a permanent exhibition of Chinese and foreign goods in this museum. In Shanghai several firms have samplerooms where is displayed almost every foreign article that China can require. The sight of many novelties has created a demand and new articles are being introduced in this way. If American manufacturers wish to extend their trade in China it would hardly be wise for them to look for assistance from the American or foreign merchant in that country. The merchants look after their own interests primarily; they don't consider it their business to develop trade between any particular markets unless there is a personal gain in doing so. Most of the large importers have settled down into a beaten track and they find that it answers their

purpose. They are, of course, open to transact business, but they don't profess to open up new markets for their goods or other people's.

While not underrating the usefulness of established importers and merchants in China it would be well for American manufacturers of engineering specialties to themselves watch the course of events in that country. The lines of trade have changed very much of late years. Old interests have died out and new methods have succeeded. Where the bulk of the business was done by British merchants, it has passed to some extent into the hands of French and German firms. For instance the French and Belgians have secured for themselves in some districts nearly all the Chinese contracts for machinery of all descriptions, arsenals, iron works and mints being fitted with their manufactures. The blame here, as in other branches of trade, would seem to lie with the firms in England who apparently make no serious attempts to push their goods in opposition to those of other countries. To send illustrated catalogs and price lists to local firms is not enough. The only effectual method is to send accredited agents with full particulars to the official in charge of factories in order to expound the advantages of American-made machinery, or to native merchants in order to point out the superiority of the article which they are trying to sell, and to secure orders therefor.

It is the manufacturer who must go to the trouble and expense of pushing his goods and creating a demand for them. When that stage has been reached he can safely leave the rest to the resident merchant. It would be unreasonable to ask any one manufacturer to go to the expense single-handed, but it would seem possible for a number of firms who do not compete to combine in investigating the possibilities of the China market and share the expense of introducing their goods. For instance, the demand for mechanical appliances will grow, but it will grow more quickly if the Chinaman is not left to discover the advantages of them unaided. It is necessary to have an expert who can demonstrate that an article is needed, and then proceed to inform his customers how it can be procured. It is reckoned that when China has as large a foreign trade as Japan, China will import six times as much iron, steel and other metals as she does now; twenty-six times as much machinery; three times the quantity of electrical materials and fittings, etc.

While referring to electrical work, I may recall the fact that the United States government agent at Shanghai finds that China has enjoyed less development along civil and electrical engineering lines than any other country of its size and importance, and presents a field which has evidently appealed to German, British and Japanese firms. Although the latter are on the ground they are poorly equipped and inefficiently represented. It is an opening that presents great chances for American engineers and manufacturers if they will attack the difficulties with the same ability that characterizes their operations in the home market. In Shanghai there are two companies—both British—controlling the supply trade. At Tientsin a German firm has supplied the electrical machinery for lighting purposes, except the boilers and the pumps, which are British. More attention should be paid to the qualifications of men who are to manage a practical part of business, i.e., men who are to sell goods abroad. A wide experience is necessary, for abroad one has to know something of everything. There is no more valuable experience than that of the traveler who has "worked new ground" successfully at home; no mere collector of orders, but a maker of business.

Exporting houses should follow the usual German method of giving a commission on profits or sales to salesmen and managers in addition to salary. Manufacturers in sending abroad should be content to let their representatives work up business and pass it through merchant houses, otherwise the merchants will push other goods, and purposely avoid those of firms who work direct. If a merchant introduces and works up a trade for certain goods his interest should be protected by giving him the sole sale of a special line, and selling to other firms only different productions, thus avoiding danger of absolute monopoly while at the same time giving the worker his reward.

If a course like this is not pursued one firm has all the work and another later on reaps the reward. Foreign representatives should return home every few years to visit manufacturing centers and warehouses, see new products, and thus get into touch with home markets again. Nothing can very well be substituted for this, as the foreign representatives are the men who have to sell the goods. Manufacturers should supply ample ranges of goods, if expensive, on the principle of so much business, such a value of new samples up to a point, say $1000 worth of samples sent on sale or return, but if business follows to the extent of $20,000 the samples to become the merchant's property. Samples should be properly marked and accompanied by proper details giving lowest cost, mode of packing, discounts, size and weight of cases, so that laying down cost can be calculated. Catalogs should be illustrated plainly and well, all details and prices being given, with the item and in the same place, and mailed direct to the merchants in China.

London, England. F. C. C.

One of the largest testing machines ever built is now under construction by Messrs. W. & T. Avery, Ltd., Soho Foundry, Birmingham, England. This machine is being built for the Birmingham University, and will be used for testing complete girders, columns and bridge, roof and machine parts in general. The machine will be operated by a hydraulic cylinder and ram and is designed to test specimens in tension up to 25 feet, in compression up to 30 feet, and transversely up to 20 feet long. Its maximum capacity is 300 tons; its total length, 70 feet. The weight of the metal in the machine is about 85 tons.

Richard Moldenke, secretary of the American Foundrymen's Association, informs us that the 10th convention of that association will be held in Cleveland, Ohio, June 5, 6 and 7. A cordial invitation has been extended to the association by the foundry and manufacturing interests of Cleveland. An attractive series of papers has been arranged for, and the secretary is assured of the warm hospitality of the residents of Cleveland. Special arrangements have been made for the entertainment of ladies who may accompany members to the meeting.

A Hartford (Connecticut) paper estimates that when additions to manufacturing plants in that city, now in progress of completion, are made ready for operation, the city of Hartford will need to secure from outside sources at least a thousand additional mechanics. The condition is very much the same in other parts of the country, the machine shops of the middle West being particularly anxious to secure all the men that can be found. No one who can do anything useful about a machine shop needs to be long idle in these times.

Personal.

Walter C. Allen, for several years past assistant to the late Frederick T. Towne, of the Yale & Towne Manufacturing Company, of Stamford, Conn., has been appointed general superintendent of the plant, this being the position filled by Mr Towne up to the time of his death last month. Mr. Allen entered the employ of the company as a truck boy at the age of 14 and has worked his way up to positions of responsibility.

Obituary.

Harry F. Peters, boss patternmaker at the Camden Iron Works, Camden, N. J. died recently at that place, aged 43 years

Morris C. Fegley, a foreman at the Bethlehem Steel Works, Bethlehem Penn., died recently at his home in Allentown, from injuries received a month before in a fall from the roof of his house He was 46 years of age.

Thomas Halloway, one of the head machinists at the Pennsylvania Railroad Company's Pavonia car shops died at his home in Camden, N. J., March 5, after a long illness. He was 62 years of age, and was a veteran of the Civil War. He had resided in Camden for 20 years.

Frank S. Cowles, president and treasurer of the Norwalk Lock Company, Norwalk, Conn., died at his home in that place March 9, after an illness of several weeks. Mr. Cowles had been connected with the concern about 25 years, and had been its president for the past three years. He was 43 years old.

Business Items.

The E. G. Smith Co., Columbia, Pa., has its plant all installed in its new building. It has increased its capital and facilities for the manufacture of its Which Way pocket level, Columbia sliding caliper and other tools, and is better able than ever to fill all orders promptly.

The Diehl Manufacturing Company has just completed the installation of an electrical equipment of a large manufacturing plant at St. Johns, P. Q., Canada. The plant consists of four 250-kw. engine type generators at 150 r.p.m. and one 100-kw. at 260 r.p.m. Also a 100-kw. motor generator set and about 30 motors, varying in size from 75 h.p. to 7½ h.p.

The Equipoise Rivet Company, Waterbury, Conn., has been organized under the laws of Connecticut and has purchased the plant and business of Hotchkiss Brothers, of Wallingford, Conn., and will move same to Waterbury. It will enlarge its Waterbury plant and will manufacture rivets, metal specialties and a combination machine test indicator.

The annual meeting of the stockholders of the Niagara Machine Tool Works, Buffalo, N. Y., was held on March 7th. Geo. A. Lautz was elected president, Adam E. Heinz, vice-president, Geo R. Munschauer, treasurer, and Francis Looney secretary. In addition to these officers, Otto J. Lautz, Charles Hughson and Geo. A. Austin constitute the board of directors. Their business is in a prosperous condition, about 250 operators being employed exclusively in the manufacture of presses, shears, tinners' tools and other machinery for working sheet metals.

The Main Belting Company, Philadelphia, Pa., during the past year has built, on the very latest and most approved lines, as addition to its plant which will very greatly increase its output and enable it to at least measurably keep pace with a demand for its Leviathan belting which is ever increasing. This belting is successfully run exposed to heat, cold, wet, grease or grime, flying sparks, etc. the Main Belting Company issues a small booklet which treats of the make-up and capabilities of its output, which it informs us it will be pleased to send by mail to any of our readers who desire to investigate the claims of its belting.

Manufacturers.

S. C. White, Anniston, Ala., will erect a foundry.

The American Drill Company of Springfield, Ohio, will move to Marion, Ind.

The Glencoe Foundry Company, Young America, Minn., will enlarge its plant.

The Peoria (Ill.) Artificial Ice Company, will build a new plant to cost $100,000.

The Des Moines (Iowa) Gas Engine Company, will build an addition to its plant.

The Morgan Construction Company, Worcester, Mass., will erect a two-story addition.

The Bay City (Mich.) Gas Company, is preparing to make an addition to its plant.

The Union Steam Pump Company, Battle Creek, Mich., will build an addition to its plant.

The Newton (Kan.) Ice Company, will erect a new artificial ice plant to cost about $75,000.

The International Correspondence Schools, Scranton, Pa., will erect a new two-story printery.

The Globe Soap Company, Cincinnati, Ohio, will spend about $600,000 on a new plant at St. Bernard.

An engine and boiler house will be erected for the Beverwyck Brewing Company, Albany, N. Y.

The Johnson Manufacturing Company, Urbana, Ohio, making oil cans will erect a new factory.

The Pfeiffer & Smith Company, Machinists, Milwaukee, Wis., have completed plans for a new $18,000 factory.

Brooks Brothers, St. Paul, Minn., sash, doors, etc. will invest $20,000 in a new factory and dry kiln.

The foundry at the plant of the United States Radiator Company, Dunkirk, N. Y., was destroyed by fire.

An addition will be built to the foundry of the S. B. Sexton Stove and Manufacturing Company, Baltimore, Md.

The Mechanics Planing Mill Company has been incorporated at Oklahoma City, Okla. President, F. M. Agee.

The J. D. Randall Company, manufacturers of leather making machinery, Cincinnati, Ohio, is to erect a new plant.

The New Phoenix Foundry & Machine Company, Springfield, Mo., is erecting a new plant which will cost $50,000.

The Pittsburg Valve and Fittings Company, will double its plant at Barberton, Ohio, expending about $500,000.

The American Steel Foundries at Granite City, Ill., are having plans drawn for improvements to cost about $200,000.

The Hoggson & Pettis Manufacturing Company, New Haven, maker of chucks, dies, tools, etc., will erect a new foundry.

The Atlantic Portland Cement Company, of Easton, Pa., has been incorporated with a capital of $100,000. H. D. Maxwell, president.

The Union Radiator Company is being incorporated at Johnstown, Pa. George S. Gore, Herman E. Baumer, and others, incorporators.

The Power and Mining Machinery Company, Cudahy, Wis., will double the capacity of its foundry, involving an expenditure of about $300,000.

The Waverly (Iowa) Industrial Association has completed arrangements for the location of a $500,000 beet-sugar factory at that place.

A power house, to cost about $500,000, will be erected at Wilmington, Del., for the Maryland Telephone and Electric Company of Baltimore.

The Kalamazoo (Mich.) Laundry Company, has let contract for a new $40,000 plant. An electric plant and water softening plant will be installed.

The Wordward Iron Company, Wordward, Ala., has increased its capital by a million dollars, and it is said will probably erect a steel mill.

The Walla Walla (Wash.) Lumber Company, has been incorporated with a capital stock of $60,000 and will erect a planing mill to cost $15,000.

William Schollhorn Company, New Haven, Conn., makers of pliers and tools, will put up a new factory building, also a power house and forge room.

The Utah County Light and Power Company, American Fork, Utah, and elsewhere, will put up two new plants, a steam plant and a water power plant.

The American Car and Foundry Co., is making preparations to spend about $30,000 in Berwick, Pa., in the enlargement of its power plant at that place.

The Waterbury (Conn.) Metal Company, has been incorporated. Frank P. Welton, Robert D. Somers, Abel Kenworthy, incorporators. Capital, $100,000.

The Warren Woodworking Company, of Philadelphia, Pa., whose plant at Belvidere, N. J., was burned a short time ago, will put up another on a larger scale.

The Norfolk & Western Railway Company, will make extensive improvements at the Roanoke, Va. shops, which will include a new foundry, to cost about $365,000.

The Alfred Bloom Company, manufacturers of sash, doors and fixtures, Omaha, Neb., will erect an addition and increase the capacity of its plant one-third.

The Hamburg Vitrified Brick Company, Ltd., Allentown, Pa., whose plant was destroyed by fire sometime ago, has commenced the erection of a new $75,000 plant.

The Kucera Windmill Machine and Foundry Company, of Grand Island, Neb., has filed articles of incorporation. Capital $50,000. R. Homalka, G. L. Kucera, etc., incorporators.

The Terry Steam Turbine Company has been incorporated at Hartford, Conn., with a capital stock of $250,000. Edward C. Terry, Lewis C. Grover, John Hunter, Incorporators.

The Stoever Foundry and M[illing] Company, Myerstown, Pa., [have] plans for increasing its facili[ties] the improvements contemplate[d] tion of another machine shop.

Catalog Notices

Scully Steel & Iron Company Chicago, Ill. Stock list for March and April, 1906. Illustrated, 4½x7, pp. 144, paper.

R. M. Clough, Tolland, Conn. Catalog and price list of gear and milling cutters, small tools. Illustrated, 3½x6½, pp. 16, paper.

National Electric Co., Milwaukee, Wis. Bulletin No. 367, illustrating and describing type "NL" direct current motors and generators.

Electro-Dynamic Company, 11 Pine St., New York. Circular No. 22 and Circular No. 23 (superseding No 16) on the Inter-pole variable-speed motor.

Fay & Scott, Dexter, Me. Catalog No. 13 describing extension gap engine lathes. This contains specifications and fine half-tone illustrations. 6x9 pp. 24, paper.

The Goldschmidt-Thermit Co., 43 Exchange Place, New York. Pamphlet containing instructions for the butt-welding of pipes and rods by the Thermit process. Illustrated, 5½x9, pp. 10, paper.

The J. Geo. Leyner Engineering Works Co., Denver, Colo. Catalog No. 8, describing the Leyner rock terrier drill. This contains a list of the different parts of the drill, also illustrations of air compressors made by this company, and copy will be mailed on request. 7x9, pp. 31, paper.

American Steam Pump Co., Battle Creek, Mich. Booklet containing tables of details, sizes and prices of Marsh boiler feed pumps. Illustrated, 3½x6, paper.

Roth Bros. & Co., Chicago, Ill. Bulletins illustrating and describing Roth dynamos, motors, electric motor grinding and polishing machines, electric forge blowers.

National Machinery Co., Tiffin, Ohio. Bulletin No. 10, January, 1906, describing single bolt cutters and containing table of dimensions. Illustrated, 8½x11, pp. 24, paper.

Brown & Sharpe Manufacturing Company, Providence, R. I. The annual reprint of this well known catalog with several additions of new machines and small tools. 4x6, pp. 514, cloth.

Buffalo Forge Co., Buffalo, N. Y. Catalog No. L G 5, describing blacksmith tools, including combined punch and shear, tire upsetters, drills, etc. Illustrated, 6½x7, pp. 16, paper.

The Standard Welding Co., Cleveland, Ohio, Pamphlets "Seamless Steel Tubing", "Seamless Steel Rims", "Welding by Electricity". These are 3½x6½ and contain a number of illustrations.

Rivett Lathe Mfg. Co., Boston, Mass. 1906 catalog of lathes, milling machines, grinders, attachments, etc. This is well illustrated and contains several tables, price lists and list of users. 6x9, pp. 111, paper.

The Ridgway Dynamo & Engine Co., Ridgway, Pa. Bulletin No. describing the McEwen engine. Specifications of simple and compound engines and tables of horse-power are given. Illustrated, 8x10½, pp. 20, paper.

The Whitman & Barnes Mfg. Co., Chicago, Ill. Catalog describing twist drills, reamers, screw and drop forged wrenches, spring cotters, and various other supplies manufactured by this company. Illustrated, 3½x6, pp. 96, paper.

Beach [illegible] Co., 109 Sixth St., Long Island City, N. Y. Circular containing illustrations and price lists of vacuum pumps and positive pressure blowers. Also pamphlet describing gas and blast-heated pressing irons. Illustrated, 6x9, paper.

B. F. Barnes Co., Rockford, Ill. 1906 catalog entitled "Twentieth Century Machine Tools" which describes the upright drills, gang drills, lathes, tool grinders and key seaters made by this company. This is illustrated by fine half-tone illustrations. 6x9, pp. 77, paper.

Keuffel & Esser Co., 127 Fulton St., New York. 1906 Catalog showing line of drawing materials and surveying instruments manufactured and imported by this company. This is much larger than previous catalogs, containing new instruments and other things. 5½x9, pp. 532, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Machine Shop Foreman—Wisconsin-Maine, on gasolene engines. Good opportunity. $1000 to start. C 4312. Engineering Agency, Inc., Chicago.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia, Pa.

Work Wanted—We are thoroughly equipped for bulding fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

Screw Machine Foreman—Ohio—qualified to handle 200 hands and automatics. $35 per week. C 4319. Engineering Agency, Inc., Chicago, Ill.

Wanted—Rotary shear 30-inch throat, lathe, planer, drill press, arch power perforating press roller feed. Room 16, 187 Broadway, N. Y.

Tool Designer—Must be up on intricate fixtures and jigs for manufacture of small interchangeable parts. C 4315, Engineering Agency, Inc., Chicago.

Mechanical Draftsman—Indiana—elevating and conveying machinery; will be only draftsman, good opening. $75. C 5357. Engineering Agency, Inc., Chicago.

Wanted—To trade a 30-h.p. Armington & Sims engine or a 60-k.w. General Electric 1000-volt monocyclic. 60-cycle generator for a lathe of about 24" swing. Box 333, AM. M.

Foreman—Michigan—to take charge of four cylinder chassis assembly work in small automobile factory. $22-$24 per week. C 5356. The Engineering Agency, Inc., Chicago.

Assistant Superintendent—East; familiar with prices of labor and fixing same; piece work premium systems, contract systems and cost work. $1800-$2500. C 5355. The Engineering Agency, Inc., Chicago, Ill.

Gray Iron Foundry in New England desires to take up the manufacture of some specialty required high-grade castings, preferably castings having intricate cores and requiring minimum of machining. Box 344, AM. M.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

Proposals will be received at the Bureau of Supplies and Accounts, Navy Department, Washington, D. C., until 10 o'clock a. m., April 3, 1906, and publicly opened immediately thereafter, to furnish naval supplies as follows: Sch. 399: One concrete mixer for delivery at the naval station, Guantanamo, Cuba.—Sch. 401: One engine lathe for delivery at the navy yard, New York, N. Y. Applications for proposals should designate the schedules desired by number. Blank proposals will be furnished upon application to the navy pay office, New York, N. Y., or to the Bureau. H. T. B. Harris, Paymaster-General, U. S. N. 2-27-06.

Notice to contractors—Sealed proposals suitably endorsed on envelope for repairs to heating system main building, East Division, Manhattan State Hospital, Ward's Island, N. Y. will be received up to 3 o'clock p. m., on Wednesday the 4th day of April, 1906, by the State Commission in Lunacy, at the Capitol, Albany, N. Y., when bids will be opened and read publicly. Drawings and specifications may be consulted and blank forms of proposals obtained at Manhattan State Hospital, Ward's Island or by application to G. L. Heins, State Architect, in the Capitol, at Albany, N. Y. Contracts will be awarded to the lowest responsible and reliable bidders unless the bids exceed the amount of funds available therefor, in which case the right to reject all bids is reserved. T. E. McGarr, Secretary State Commission in Lunacy. Albany.
Dated March 6, 1906.

For Sale.

For Sale—Foundry, Wood & Iron machine shops, Albion, N. Y. Box 74.

For Sale—Foundry and machine shop in town of 2500, eastern Iowa; well equipped for work; good opportunity for right man. Address Box 316, AMERICAN MACHINIST.

For Sale—Gas engine business with engines from two to sixty horse-power capacity. Stock of finished and unfinished engines and patterns, drawings, etc. Will sell at a bargain. Apply Box 55, AMERICAN MACHINIST.

For Sale—1—12 Point Waggoner Watchman's Clock, and 1—20 Point Waggoner Watchman's Clock. 32 Magneto boxes for same All in first-class shape. Will sell at a reasonable price. If interested, address Purchasing Department, Olds Motor Works, Lansing, Mich.

For Sale—Whole or part interest, large plant including foundry, machine shop, pattern shop and forge shop, doing a general mining machinery and packing house machinery manufacturing business, employing from 100 to 200 men. Centrally located. Box 313, AMERICAN MACHINIST.

For Sale—One-third to one-half interest in established manufacturing business to good business man only. Business has increased from $10,000 per annum to $60,000, capital is insufficient for work on hand. Assets $24,000. Capital required $7000 to $10,000, managed rightly should pay good dividends. Box 335, AMERICAN MACHINIST.

Business Opportunities.

Office or mechanical man to invest $10,000 to $15,000 with services in growing foundry and machine shop controlling patent specialties, doubling its capacity the past 6 years. Good opportunity for young man. Address P. O Box 1456, St. Louis, Mo.

A young man (29) who has had a technical education and eight years' experience selling machine and electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented on either salary or commission basis. Box 280, AMER. MACH.

A Manufacturing Concern having a varied line of machinery, wishes to dispose of one of its lines which consists of stationary gasolene engines. These engines run in sizes of from 2 to 20 H.P., and are adapted for all kinds of work. Business in this line has run $50,000.00 a year. Patterns, drawings and good will will be sold at a reasonable figure. Parties desiring to add another line to their business, or those desirous of going into the manufacturing business will find this to be an interesting proposition. Address Gas Engine, 260 AMERICAN MACHINIST.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should not be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Expert accountant and office manager desires position. Familiar with all branches of office work. References. P. O. Box 55, Hartford, Conn.

A No 1 mechanic wants position as assistant superintendent or foreman, constructor of fine machines, familiar with manufacture of typewriters, especially adding machines and cash registers. First class references, 25 years experience. Box 328, AMER. MACH.

INDIANA.

A machine designer with a varied experience on medium and heavy machinery technical graduate with 6 years experience, age 30. A leading position with a progressive firm is desired. Box 309, AMER. MACH.

IOWA.

Chief Draftsman; a mechanical engineer, at present chief draftsman with a large manufacturing concern in the west. Box 269, AMERICAN MACHINIST.

MASSACHUSETTS.

Factory office clerk. Several years experience in general office work, also as cost keeper, purchasing agent and systematizer. Box 341, AMERICAN MACHINIST.

Toolroom foreman, or assistant superintendent, by an expert, practical, technical, and inventive, 12 years experienced toolmaker, 31, on tools, jigs, fixtures and high-speed steels. Box 319, AMER. MACH.

MICHIGAN.

Technical graduate, age 30, with shop, drafting room, and manufacturing experience, desires position as assistant to Engineer or Superintendent. Box 334, AM. M.

NEW JERSEY.

Position desired by mechanical draftsman. Box 288, AMERICAN MACHINIST.

Metal pattern maker with a thorough knowledge of machine molding wants position. Can obtain the low cost in foundry. Capable to take charge. "J. H. G.," 794 Broad St., Newark, N. J.

Wanted—Position as Works Superintendent or assistant. Modern methods. Can handle men to best advantage. Expert on jigs and tools. General practice in pump line. Best references. Box 336, AM. MACH.

A master mechanic and experienced tool maker desires to move his machine and tools on account of railroad taking premises. Wants employment with or without outfit. Machinery consists of B. & S., Hendey, and other machines. Address 705 Summit Ave., Jersey City, N. J.

NEW YORK.

Mechanical draftsman wishes position. Address Box 307 care AMERICAN MACHINIST.

Master Mechanic of extended practical experience. Technical graduate and a hustler. Box 320, AMERICAN MACHINIST.

Superintendent or manager general machine and boiler shops; experienced on marine repairs. Box 321, AMERICAN MACHINIST.

By a first-class all around practical up to date machine shop foreman, experienced in engines, hydraulic machinery and general repairs or inspector for construction company. Best of references. Box 330, AMER. MACH.

Cost expert and manager wants position with large machinery or automobile concern. Experienced as professional business systematizer and is Certified Public Accountant. Now managing instrument and metal goods factory. Box 326, AMERICAN MACHINIST.

Mechanical Engineer, graduated from German University, best references, 29 years old. For 6 months with large electrical company in United States. Has many fine inventions, railway, automobile, locomotives, pumps, tools, etc.; wants good position. Box 329, AMERICAN MACHINIST.

PENNSYLVANIA.

Technical graduate (31) with 10 years experience in the office and drafting room on electrical and other machinery, desires a position in the sales or advertising department of a reliable firm. Box 342, AMER. MACH.

Mechanical engineer, practical mechanic, 15 years experience in erection and operation of engines, pumps, boilers, sugar-house machinery; also experienced in construction of steel and wooden structures, glass-house furnaces and concrete foundations, desires a position of responsibility. Box 302, AMERICAN MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Tool-makers, experienced on gauge, fixture and die work. Apply Ross Rifle Company, Quebec, Canada.

CONNECTICUT.

First-class die sinkers accustomed to drop forged work. State experience and wages wanted. Kilborn & Bishop Co., New Haven, Conn.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

INDIANA.

Wanted—Manufacturing superintendent light machine manufacturer, good experienced man only need appy. Address R 310, AMERICAN MACHINIST.

IOWA.

Wanted—Three operators for screw machines in a Western city. State experience and kind of machines familiar with. Box 332, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Gear cutting expert, bevel gear and spiral man preferred. Boston Gear Works, New Shop, Norfolk Downs, Mass.

Wanted—Draftsman well experienced in designing ring oiler bearing. Only a first-class man will fill the requirement. B. F. Sturtevant Co., Hyde Park, Mass.

MICHIGAN.

Wanted—Ten first-class die makers. Experienced on drawing, forming and blanking dies. New Modern Shop. Good wages to good men. Inventors' Mfg. Co., Kalamazoo, Mich.

NEW JERSEY.

Draftsmen—We have positions now open for draftsmen. Call or address Henry R. Worthington, Harrison, N. J.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Experienced engine draftsmen wanted at once. Must be steady and accurate. Give full particulars. Ball & Wood Co., Elizabeth, N. J.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—An experienced mechanical draftsman accustomed to light machine design and tool work. State age, experience and salary expected. Box 315, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit applications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

Draftsmen Wanted—One or more draftsmen required at once. Men who are familiar with pumping machinery and condenser designs preferred. Reply by letter or in person. Henry R. Worthington, Harrison, N. J.

NEW YORK

Wanted—Draftsmen for jigs, fixtures dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Experienced tool and gauge makers. Best wages paid for first-class men. Remington Arms Company, Ilion, N. Y.

Wanted—Die sinkers. Pay from $3.25 to $4.00 per diem. Apply to Board of Labor Employment, Navy Yard, Brooklyn, N. Y.

Draftsmen Wanted—Those experienced on engine work preferred. State age, nationality and wages expected. Box 311, AM. MACH.

Wanted—Manager, to have general oversight of bookkeeping, purchasing, costing and shipping departments of large manufacturing company. Box 327, AMERICAN MACHINIST.

Toolmakers—Wanted immediately, first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—A competent designing draftsman, with experience in centrifugal pumping machinery; state age, experience and salary expected; location New York State. Box 298, AMERICAN MACHINIST.

Superintendent wanted for automobile works employing 600 men. Applicants must be thoroughly experienced. State age, references, and salary expected. Address Box No. 312, AMERICAN MACHINIST.

Machinists—For floor work. Permanent employment for good men. Wages $2.50 per day; 9 hour work day; time and half for overtime, double time for holidays. Location 25 miles from New York City. Box 268, AMERICAN MACHINIST.

Milling Machine Operators. First class operators on Brown and Sharpe Universal Milling Machines on tool work. Must be able to set up machines and work from drawings. Apply to the Western Electric Co., 57 Bethune St., New York City.

Machinist hardener and temperer; to be experienced on B. & S. case-hardening, gas furnace tool-hardening, of taps, punches, dies, cutters, reamers, etc. Preference given to one understanding high-speed steel hardening. Address, Steady Work, 343, AMER. MACH.

Draftsman—Wanted by company building elevating and conveying machinery. Experience in the line specified is desirable, but not absolutely essential. None but high-grade men need apply. State experience, salary expected and when at liberty. Box 324, AM. M.

Man Wanted to take charge of about twenty boys, one used to clock work or small interchangeable parts. State experience and wages wanted. Steady job in a growing concern, working 54 hours per week in New York City. Box 314, AMERICAN MACHINIST.

Managing foreman or mechanical superintendent for factory, 100 men, making instruments of precision and small articles of all kinds of metal. Must be good executive and command respect and obedience of workmen. Fine opportunity. Good salary. Answers considered strictly confidential. Box 325, AMERICAN MACHINIST.

Fort Totten, N. Y., March 10, 1906. Wanted—Master Electricians for Coast Artillery, U. S. Army. Graduates of standard schools of technology or others of equivalent theoretical education, and three years practical experience with steam and electricity, under 33 years of age and unmarried. Pay and allowances as follows: Pay $75.00 per month. Allowances: house, food, clothing, fuel, light, medical attendance, etc. After 30 years' service, retirement on three quarters pay and allowances. For further particulars, apply to Secretary, School of Submarine Defense, Fort Totten, N. Y.

OHIO.

Wanted—First-class mechanical draftsmen, experienced in machine tool work. The Niles Tool Works Co., Hamilton, Ohio.

Wanted—Designer and draftsman for punch presses, power squaring shears and drop hammers. Box 270, AMERICAN MACH.

Wanted—Draftsman. One familiar with automobile work preferred. None but first-class draftsmen need apply. Box 340, AM. M.

Wanted—Foreman for body and running gear finishing and assembling department in large automobile works. Must have had previous experience in this line. Box 339, AMERICAN MACHINIST.

Wanted—Foreman experienced in gas engine work to take charge of engine assembling department in large automobile factory. Must be a hustler and come well recommended. Box 337, AMER. MACHINIST.

Wanted—Foreman to take charge of repair department in automobile factory. Must have had experience with high grade American and foreign cars and be able to handle men to advantage. No others need apply. Box 338, AMERICAN MACHINIST.

Wanted—First-class man to take charge of designing of up-to-date jigs and fixtures for machine tool work. Must be capable of giving instructions in use of the same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—High-grade erecting machinists for air compressor work. The Blaisdell Machinery Co., Bradford, Pa.

Wanted—First class draftsman, familiar with paper-mill machinery. Box 331, AM. M.

Wanted—Lathe hands, experienced in heavy roughing work. Steady work at satisfactory wages. Apply Titusville Forge Co., Titusville, Pa.

Wanted—First class instrument and toolmakers; also large machine tool operators. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

Wanted—A number of mechanical draftsmen; those with experience in electrical apparatus, generators or motors preferred. Only first-class men need apply. Address Chief Draftsman, Westinghouse Electric and Manufacturing Co., East Pittsburg, Pa. (P. O. Box 911.)

The Monotype Company maintains a free school for training young machinists to operate its type casting and composing machines. The demand for Monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight: character, common sense, experience with automatic machinery, (or) printing-office experience, or type foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket, R. I.

WISCONSIN.

Tool and die makers—Wanted several first-class men on stamping die work, both plain and compound. State age, married or single, and when can come. Northern Electrical Mfg. Co., Madison, Wis.

Wanted—Machinists ambitious to be foremen or sub-foremen. Our growing automobile business often furnishes opportunity for advancement. Thomas B. Jeffrey & Co., Kenosha, Wis., Rambler Automobiles.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential. Box 919, AM. M.

WEST OF MISSISSIPPI.

Experienced punch and die makers, those with experience with sub-press work preferred. Steady work and first class wages guaranteed to good men. Box 318, AM. M.

Draftsman with experience in light automatic machinery, with some experience in designing tools for the manufacture of same, Exceptional good opportunity for a good practical man. No others need apply. Box 317, AMERICAN MACHINIST.

Wanted—General superintendent to take charge of factory employing three-hundred hands; one having had experience in making typewriters or adding machines preferred. Give experience, references and salary expected. Box 275, AMERICAN MACHINIST.

Wanted for California, practical machinist and experienced salesman combined, to sell general line of machinery; must have good executive ability, initiative, judgment, and be sober. We want men who forget hours and everything else when business is in sight, who do not need to be told every minute, but who can do as told, meet conditions and can see a future as well as the immediate dollar. State age, experience (fully) and full particulars. Box 322, AMERICAN MACH.

Wanted for California, practical engineer and experienced salesman combined, to sell general line of engines, boilers, etc.; must have good executive ability, initiative, judgment, and be sober. We want men who forget hours and everything else when business is in sight, who do not need to be told every minute, but who can do as told, meet conditions, and can see a future as well as the immediate dollar. State age, experience (fully) and full particulars. Box 323, AM. M.

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U. S Foundry & Sales Co., South Norwalk, Conn.

Castings, Steel
Birdsboro Steel Fdry. & Mach. Co., Birdsboro, Pa.
Farrel Fdry. & Mach. Co., Ansonia, Conn.
Kent & Co., Edwin R., Chicago, Ill.

Cement, Cast Steel
Clark Cast Steel Cement Co., Shelton, Conn.
Deek, Chas., Bayonne, N. J.

Centering Machines
Hendey Mach. Co., Torrington, Conn.
Hill, Clarke & Co., Boston, Mass.
Phoenix Mfg. Co., Hartford Ct.
Pratt & Whitney Co., Hartford, Conn.
Prentiss Tool & Supply Co., New York.
Whiton Machine Co., D. E., New London, Conn.

Centers, Planer
Morse Twist Drill & Mach. Co., New Bedford, Conn.
Pratt & Whitney Co., Hartford, Conn.
Woodward & Powell Planer Co., Worcester, Mass.

Chains, Driving
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Boston, Mass.

Chains, Driving —*Continued.*
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., The, Columbus, Ohio.
Link-Belt Engr. Co., Phila., Pa.
Morse Chain Co., Trumansburg, N. Y.
Whitney Mfg. Co., Hartford, Ct.

Chisels, Cold
Hammacher, Schlemmer & Co., New York.
Whitman & Barnes Mfg. Co., Chicago, Ill.

Chucking Machines
American Tool Works Co., Cincinnati, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Automatic Mach. Co., Cleveland, O.
Gisholt Mach. Co., Madison, Wis.
LeBlond Mach. Tool Co., R. K., Cincinnati, O.
Potter & Johnston Mach. Co., Pawtucket, R. I.
Warner & Swasey Co., Cleveland, Ohio.
Whitcomb-Baisdell Mach. Tool Co., Worcester, Mass.
Windsor Mach. Co., Windsor, Vt.

Chucks, Drill
Almond Mfg. Co., T. R., Brooklyn, N. Y.
Brown & Co., R. H., New Haven, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Cushman Chuck Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Horton & Son Co., The E., Windsor Locks, Conn.
Jacobs Mfg. Co., Hartford Conn.
Modern Tool Co., Erie, Pa.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles-Bement-Pond Co., New York.
Pratt Chuck Co., Frankfort, N. Y.
Standard Tool Co., Cleveland, O.
Trump Bros. Mach. Co., Wilmington, Del.
Whitney Mfg. Co., Hartford, Ct.
Whiton Mach. Co., D. E., New London, Conn.
Wiley & Russell Mfg. Co., Greenfield, Mass.

Chucks, Lathe
Cushman Chuck Co., Hartford, Conn.
Gisholt Mach. Co., Madison, Wis.
Horton & Son, Co., The E., Windsor Locks, Conn.
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.
Whiton Mach. Co., D. E., New London, Conn.

Chucks, Planer
Niles-Bement-Pond Co., New York.
Skinner Chuck Co., New Britain, Conn.

Chucks, Split
Rivett Lathe Mfg. Co., Boston, Mass.

Circuit Breakers
Crocker-Wheeler Co., Ampere, N. J.
General Elec. Co., New York.
Stanley G. I. Elec. Mfg. Co., Pittsfield, Mass.
Switchboard Equipment Co., Bethlehem, Pa.
Westinghouse Elec. & Mfg. Co., Pittsburg, Pa.

Clamps
Billings & Spencer Co., Hartford, Conn.

Clutches, Friction
Caldwell, Son & Co., H. W., Chicago, Ill.
Cresson Co., Geo. V., Phila., Pa.
Johnson Mach. Co., Carlyle, Hartford, Conn.
Link-Belt Engineering Co., Philadelphia, Pa.
New Haven Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., New York.
Patterson, Gottfried & Hunter, Ltd., N. Y.
Reeves Pulley Co., Columbus, Ind.
Wood's Sons Co., T. B., Chambersburg, Pa.

Coal Handling Machinery
Link-Belt Engineering Co., Philadelphia, Pa.

Stay-Bolt Practice of the Pennsylvania Railroad.

EDITORIAL CORRESPONDENCE.

The difficulties of stay-bolt and tap making are well known to all who have to do with them; these difficulties arising from the necessity for uniformity in pitch between the bolts and taps. The modern stay-bolt has its body reduced in diameter between the threaded ends, leaving two independent ends the threads of which must be true prolongations of each other; that is, they must be portions of the same thread, though with the central portion missing, and, moreover, this thread should have the same pitch as the long tap with which the two fire-box sheets are threaded.

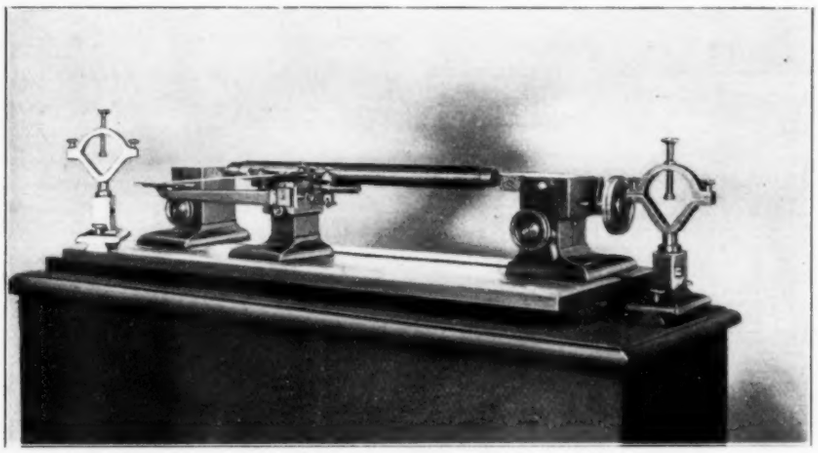


FIG. 1. STAY-BOLT COMPARATOR.

Needless to say these conditions are not often fulfilled, the result being that the bolts do not fit the holes in the sheets. The bolts will enter and fit the hole in either sheet, but when entered in both conflict begins, making it necessary to use brute force to screw the bolts home, with the result that they are under initial and unknown strain when the boiler has no pressure within it. On some of the bolts the strain is compressive and on others tensile, and, with pressure in the boiler, the latter take part of the load which the former should carry.

THE ACCURACY ATTAINED.

The thoroughly unmechanical character of most stay-bolt work led the Pennsylvania Railroad to detail A. W. Epright, of Altoona, to undertake its improvement, and the accompanying illustrations show the results of his work. So successful have his efforts been that, after two years' use of his methods the greatest error found in the bolts was 4/1000 inch negative lead in twelve inches, the bolts, be it understood, being made from ordinary rough merchant bar without straightening, selection or other preliminary work. I saw one of these bolts, selected at random from those just completed and lying on the machine and tested, and the error found was 2/1000 inch in eight inches.

WORKSHOP CHECK ON ACCURACY.

A constant check is placed on the accuracy of the bolts by making it impossible for undue force to be used when screwing them home. The wrench provided is but six inches long, and with this all bolts must be screwed to their places. It is im-

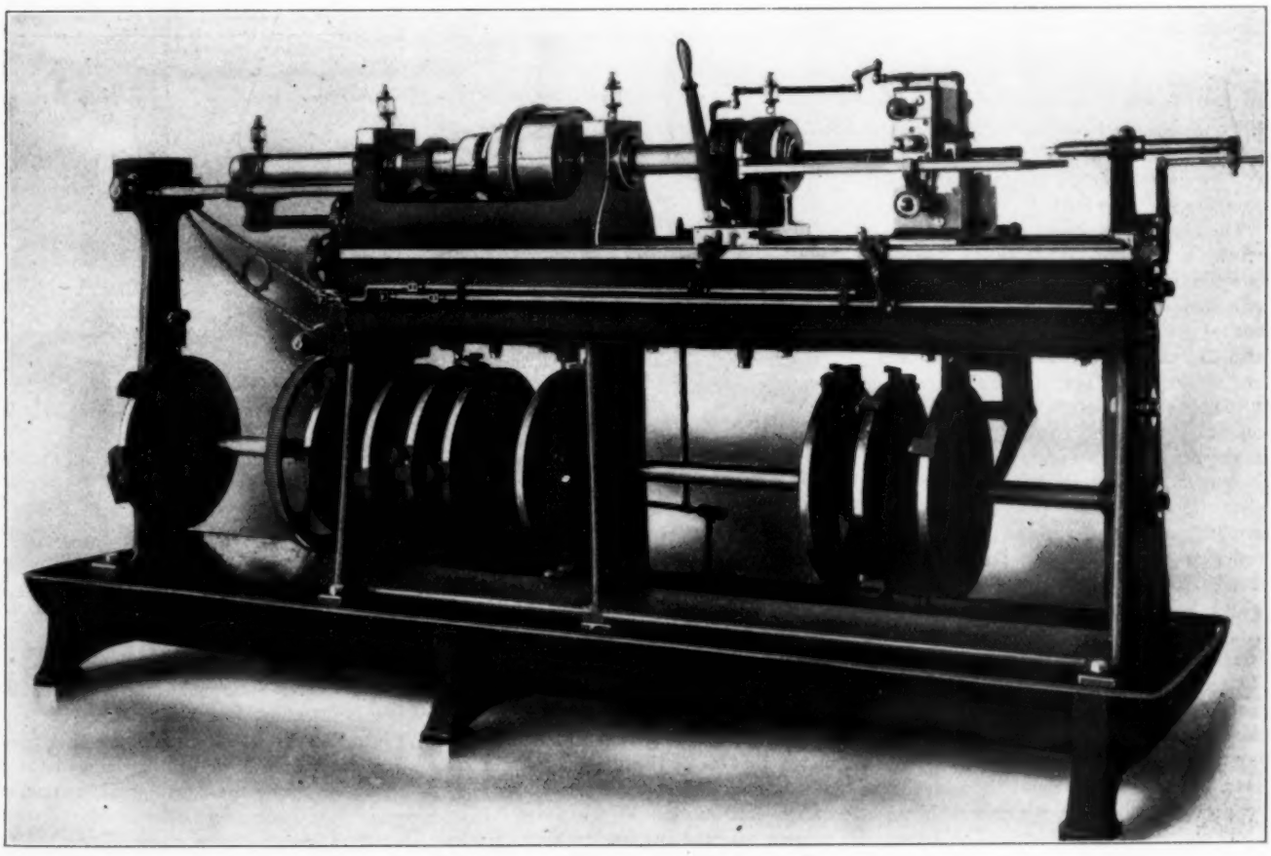


FIG. 2. STAY-BOLT MAKING MACHINE.

possible to use a different wrench from the one provided, as the bolts have no heads, the wrenches being socket wrenches which engage the threads only, and to make ineffective any surreptitious lengthening of the special wrench by welding out or using a piece of pipe, it is so made that it can engage two threads only of the bolt, these threads measuring the amount by which the bolt projects from the sheet for the formation of the head.

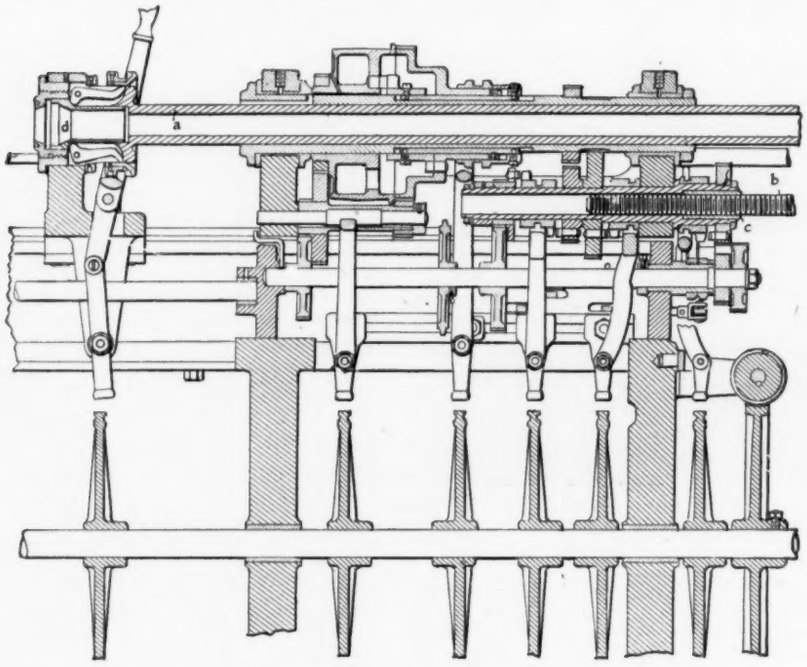


FIG. 3. SECTION OF HEADSTOCK.

A STAY-BOLT COMPARATOR.

The starting point of Mr. Epright's methods is the comparator shown in Fig. 1, by which any bolt may be quickly compared with a standard and the error in any given number of inches of its length be quickly determined.

The machine is shown with the standard screw in position supported on centers. On the front side of the machine is a standard which rests on the base, but is not fastened to it, from which projects an arm carrying an arc-shaped scale reading to thousandths. The standard carries an adjustable rod parallel with the line of centers, the outer end of which has a finger point which enters the threads. A second finger point is carried by a multiplying lever of which the outer end plays over the graduated scale. The adjustable rod being set to bring the two finger points at approximately the distance apart which is to be included in the comparison, the two points are then entered between the threads of the standard screw. By an adjustment which is provided the multiplying lever is made to read zero and the bolt to be tested is then substituted for the standard. The stay-bolts, however, have no centers and they are hence supported in V yokes, which are shown at each end of the machine. The bases of these yokes fit the slot in the bed of the machine, and they hence locate the bolt to be tested in a position which is parallel with the line of centers. The bolt in place the indicating apparatus is quickly applied to it and its error is read off.

LEAD-SCREW GUIDED DIES.

The threads of the bolts are cut by dies which are guided by a lead screw. Many doubt the ability of a lead screw to control the action of a die which is out of truth with it, especially if the die tends to cut a slightly coarser pitch than the screw, as, in that case, the die may for a time advance faster than the screw by reason of the lost motion in the parts. In the present design of bolt-making machine this question is, however, eliminated. The bolt stock being turned down between the threaded ends, the die starts afresh at the beginning of each end, and, being brought up to each starting point by the lead screw, the start of each threaded end is bound to be correct. That is, there is no continuous error accumulated throughout the entire length of the bolt, but an error, if any, accumulated through the short ends only, and such error must be substantially equal in the two ends and thus neutralize itself, as shown in a test which spans the two ends.

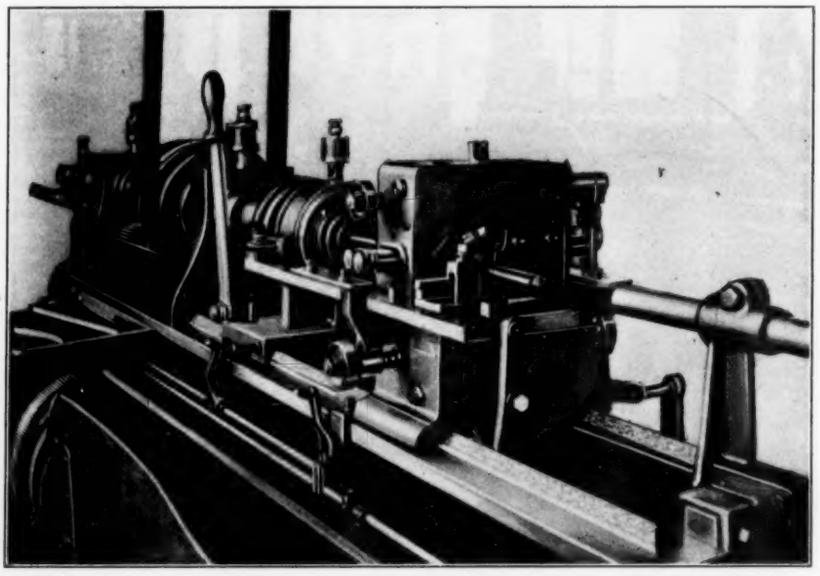


FIG. 4. TURNING AND CUTTING OFF TOOL SIDE OF TOOL BLOCK.

THE BOLT-CUTTING MACHINE.

The machines in which the bolts are cut, shown in Fig. 2, have in general much the appearance of automatic turret lathes. There is essentially the same arrangement of cam shaft and cams, but the action is quite different. The block which carries the tools and dies is stationary, the feed being by the bar itself, which is fed through the tool block. The spindle of the lathe is hollow and through it runs a long feed tube *a*, Fig. 3, which is a section of the headstock. The feed screw *b* is connected with the feed tube, as shown in Fig. 2, its nut *c* being driven in either direction and at various speeds by the gearing which connects it with the spindle, and which is engaged and disengaged in various combinations by the cams below. The bar of stock runs through the feed tube and is fed forward for each fresh bolt by feed rolls in the detached upright at the extreme left of Fig. 2. The feed for the cut is by the chuck at *d*, Fig. 3, which is engaged and disengaged by the cam below, and which has a feature in the engaging levers which close it in, that they are of a length permitting considerable spring whereby the considerable variation which exists in the diameter of stay-bolt stock may be accommodated.

In action the bar of stock is first fed

through the roller feed until it contacts with the stop at the end of the machine. The chuck, which is then at the outer end of its travel, is then closed and the bar is drawn back. A bar, shown in Figs. 2, 4 and 5, extending alongside the tool block, is attached to the chuck and has a cam face by which the turning tool is forced inward as the bar travels endwise, and is again withdrawn as the end of the reduced portion is reached, a similar bar on the other side of the tool block manipulating the steady rest. The reducing cut for the central portion of the bolt thus completed, the stock is further withdrawn to clear the dies which are on the other side of the tool block from the turning tool, as shown in Fig. 5. The feed of the bar is then reversed, the dies close and the two ends are threaded, the intervening portion of the bolt being quickly passed by speeding up the feed screw. The threading complete, the bolt is cut off by the cutting-off tool, also mounted on the side of the tool block shown in Fig. 4.

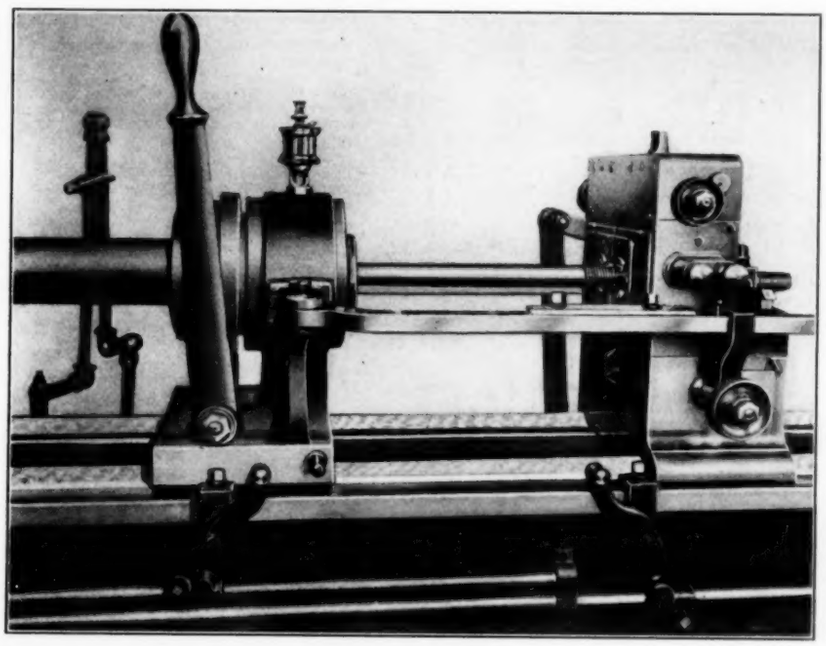


FIG. 5. DIE SIDE OF TOOL BLOCK.

FLEXIBILITY OF THE MACHINE.

When machine was designed experiments were in progress on the design of stay-bolts. Bolts had been tested having one end materially larger than the other, and there was a considerable probability that a design of this character would be adopted, making it necessary to adapt the machine to it. With such a bolt the intermediate turning down could not be done with a single chip and provision was therefore made for taking one, two or three chips; that is, in addition to the sliding bar for closing in the turning-down tool, provision is made for advancing the tool in steps for a succession of cuts. This is shown in Fig. 6, which illustrates the tool block. An arm *a*, which is actuated by a suitable cam on the cam shaft, advances the tool by its geared connection with the screw *b*, which is connected to both the turning tool and the back rest. A scale *c* indicates the cut that is in progress. Similar means are provided at *d* and *e* for advancing the dies and thus taking a finishing cut. Neither of these provisions is used, the unequal-ended stay-bolt having been abandoned, and the second cut of the dies having been found superfluous. These provisions, however, require the repeated traverse of the work, and they, together with the necessity for

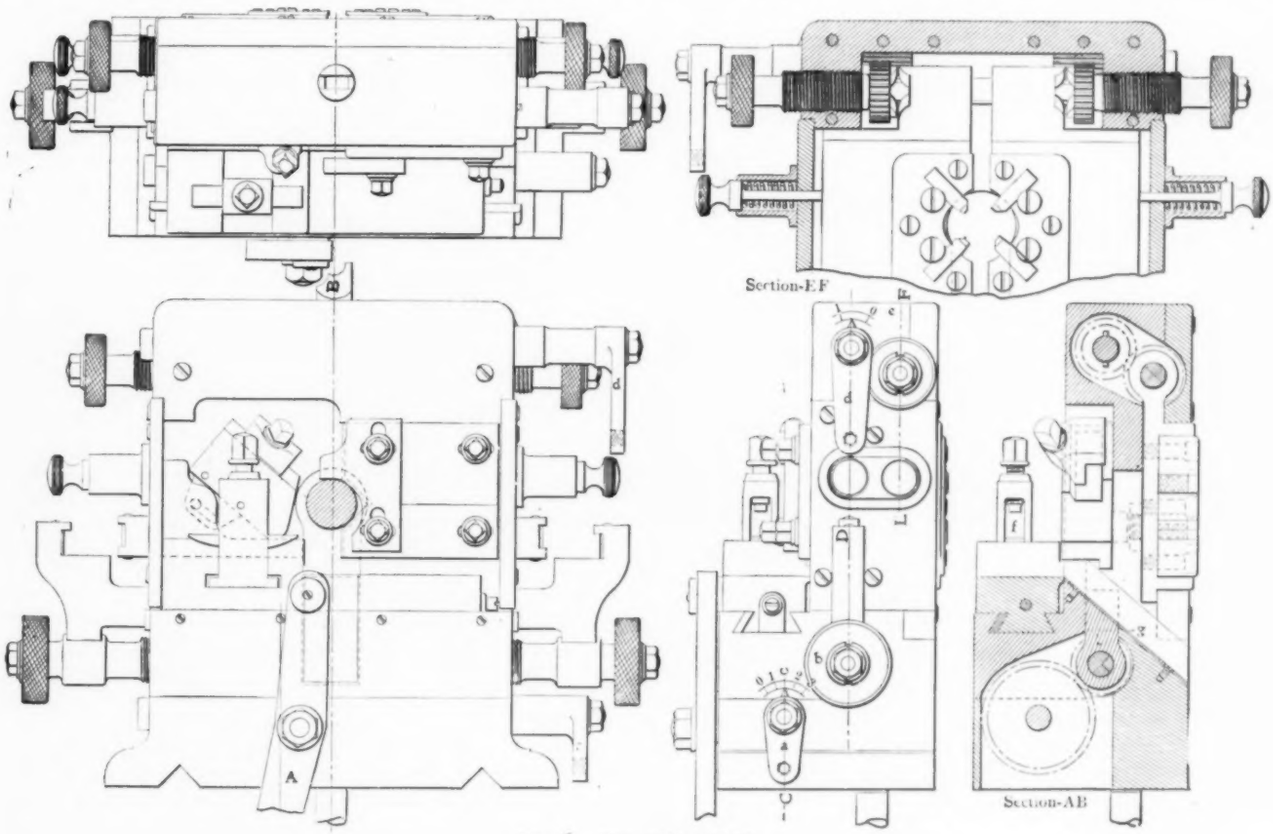


FIG. 6. THE TOOL BLOCK.

handling long bolts, require a very flexible arrangement of speeds for the cam shaft, and as a matter of fact this shaft may be made to revolve as slowly as once per hour or as quickly as once in two minutes. An outgrowth of this adjustability is a saving of time, as, regardless of the length of the bolt, the revolution of the cam shaft may be so adjusted as to be completed just as the bolt is finished, and hence the succeeding bolt is commenced without loss of time.

A feature of the tool block shown in Fig. 6 will be appreciated by automatic turret-lathe operators. The cross section at the right is taken with the observer in the rear of the lathe, looking toward the operator's side. The cutting-off tool post is shown at *f*. It will be observed that, except for those made by this tool, the chips fall on the inclined surface *g* and thus go to the right while the completed bolt drops off at the left; that is, the bolts and chips do not fall in the same pile, but each in piles of their own.

HARDENING TAPS.

Accuracy in the bolts would count for little without equal accuracy in the taps, and this latter has been secured by a wrinkle in hardening that is new to me. The taps are heated in a lead bath in the usual way, except that they are submerged for a limited time only, this time being such that the teeth only are heated to a hardening temperature. Both heating and quenching are of course done with the tap in a vertical position. The heating of the teeth only leaves the body of the tap soft, so that it may be filed or drilled, and the pitch is found to be unaltered. One of these taps, selected at random, was tested on the comparator in my presence and the error in four inches was found to be zero. No differential gear or screw is used in cutting the taps, which are cut to the intended pitch, and, as said, the hardening process described is found to leave this unaltered. F. A. H.

Power Required by Machine Tools, with Special Reference to Individual Motor Drive. *

BY G. M. CAMPBELL.

This article will not be a theoretical exposition of the subject in general but will rather present a few deductions from the various motor equipments in a modern shop, giving certain curves of power in connection therewith and various examples of every-day practice in these shops. Most of the inferences that may be drawn from these records will be left for the reader to make as he sees fit.

Just what range of speed is required in the motor cannot be definitely stated for all conditions. If a total speed range of 6 to 1 is required in a machine, it might be advisable under certain conditions to obtain this total range in the motor, but as a general rule the writer believes it would be advisable to use at least two runs of gears when the speed change required exceeds 4 to 1, and that a somewhat better and more efficient design can be obtained when the speed change required in the motor is limited to about 3 to 1. The larger the speed range the larger the motor as is shown in Fig. 2, and of course the greater the price, also the disproportion between size of motor and size of machine increases.

Machine.	Cut: Feed Inches.	Cut: Depth Inches.	Speed Ft. per Min.	Weight Removed Lb. per M.	H. P.: Actual.	H. P.: From Formula.
72″ Wheel Lathe No. 14	1/16	3/8 & 1/4	13.7	1.69	4.5	4.2
"	1/8	3/8 & 1/4	11.6	2.15	6.4	5.4
"	3/16	3/8 & 1/4	13.2	5.55	8.4	13.9
"	1/16	1/4 & 1/2	13.2	6.3	12.0	15.7
90″ Wheel Lathe No. 28	1/16	1/16 & 1/16	13.0	3.1	12.0	7.7
"	3/16	1/16 & 1/16	8.8	3.5	8.1	8.7
"	1/16	1/16 & 1/16	10.5	4.0	7.3	10.0
"	1/8	1/4 & 1/4	15.5	5.3	9.0	13.2
"	1/8	1/4 & 1/4	12.3	6.3	13.4	15.7
19″ Slotter No. 77	1/32	1/4	30.0	0.8	2.0	2.0
"	1/32	1/4	28.8	0.76	1.7	1.9
					84.8	98.4

TABLE 1. POWER ABSORBED IN CUTTING HARD STEEL.

Machine.	Cut: Feed Inches.	Cut: Depth Inches.	Speed Ft. per Min.	Weight Removed Lb. per M.	H. P.: Actual.	H. P.: From Formula.
60″ Planer No. 52	1/4	1/4	25.5	3.62	5.9	6.5
"	1/4	1/4	25.7	3.65	6.5	6.6
24″ Shaper No. 64	1/16	1/8	26.7	1.46	3.4	2.5
"	1/16	1/4	37.5	1.00	2.7	1.8
"	1/16	1/4	41.7	1.11	2.6	2.0
72″ Boring Mill No. 29	1/4	1/16 & 1/32	44	1.76	2.9	3.2
"	1/8	1/32 & 1/16	40	2.38	2.6	4.3
"	1/4	1/4 & 1/4	51	5.41	9.6	9.7
"	1/4	1/16 & 1/16	48	7.65	12.7	13.7
"	1/4	1/16	47	3.75	7.2	6.8
19″ Slotter No. 77	1/32	1/8	23.3	0.93	1.3	1.7
"	1/32	1/8	23.3	0.93	2.1	1.7
42″ Lathe No. 10	1/16	1/4	44	2.33	3.8	4.2
"	1/16	1/4	44	1.17	1.7	1.9
"	1/16	1/4	44	1.17	2.6	1.9
24″ Lathe No. 19	1/32	1/8	49.5	1.98	3.7	3.6
Axle Lathe No. 21	1/16	1/4	27	4.3	5.9	7.7
"	1/16	1/4	51	2.7	5.0	4.9
"	1/16	1/16 & 1/16	51	1.4	2.8	2.5
"	1/8 & 1/16	1/8 & 1/8	46	5.5	8.2	9.9
Car Wheel Lathe No. 22	1/16	1/8 & 1/8	12.5	6.9	12.7	12.4
"	1/16	1/8 & 1/8	12.6	6.0	9.9	10.8
"	1/4	1/4	19.7	4.2	15.1	7.6
Axle Lathe No. 13	1/16	1/16 & 3/16	43	3.43	4.9	6.2
"	1/16	1/8 & 3/16	44	2.04	3.7	3.7
"	1/16	1/8 & 1/8	33	1.75	2.3	3.1
32″ Gisholt Lathe No. 70	1/32	1/4	84	2.2	4.3	4.0
"	1/32	1/16	94	1.9	3.6	3.4
"	1/64	1/16	64	1.1	1.6	2.0
					151.3	150.3

TABLE 2. POWER ABSORBED IN CUTTING SOFT STEEL.

NUMBER OF CONTROLLER POINTS.

The controller necessary to enable the speed change to be obtained in proper increments will vary according to the range required and the size of the increment. It is feasible to work to within 10 per. cent. change of speed and consequently a 10 per cent. increment would be desirable. If 10 per cent. increments are used the number of points of the controller would be obtained from the formula:

$$1.1^{n-2} = \text{Speed range in motor.}$$

Where n is the number of points in controller, "off" point being counted as one point. This would give results as follows.

Speed Range.	Controller Points.
3	14
4	17
5	19
6	21

If the motor is a reversing one, then to this number of forward motion points must be added the required number of back motion points; usually one-third to

Machine.	Cut: Feed Inches.	Cut: Depth Inches.	Speed Ft. per Min.	Weight Removed Lb. per M.	H. P.: Actual.	H. P.: From Formula.
24″ Drill Press No. 39	1/16	enlarging 1 1/2—3	25.1	0.81	2.3	1.6
"	1/16	" 1 1/2—3	29.7	0.96	2.7	1.9
"	1/16	" 1 1/2—3	25.9	0.83	1.3	1.7
"	1/4	1 1/2″ Drill	74.5	0.52	3.5	1.0
"	1/4	2 " "	20.9	0.54	1.2	1.1
"	1/4	2 " "	20.9	0.54	2.2	1.1
24″ Drill Press No. 40	1/16	enlarging 1/4 to 2″	20.9	1.02	1.4	2.0
"	1/4	1 1/2″ Drill	36.8	0.63	2.6	1.3
50″ Radial No. 147	1/4	1 1/2″ "	53.9	0.88	2.7	1.8
"	1/4	1 1/2″ "	51.7	0.84	2.5	1.7
30″ Lathe No. 20	1/8	1/16	54	4.2	6.6	8.4
"	1/8	1/16	42	3.2	4.0	6.4
60″ Planer No 52	1/16	1/8 & 1/16	23	8.95	21.0	17.9
"	1/8	1/8 & 1/16	17.5	1.82	2.7	3.6
"	1/8	1/4 & 1/16	24.2	1.72	6.5	3.4
42″ Planer No. 55	1/8	1/8	24.3	4.73	12.1	9.5
"	1/16	1/8	25	4.87	12.3	9.8
"	1/8	1/8	36	5.7	7.8	11.4
					95.4	85.6

TABLE 3. POWER ABSORBED IN CUTTING WROUGHT IRON.

*Abstract of a paper read before the Engineers' Society of Western Pennsylvania.

one-half the number of forward, so it is seen that the controller would become unwieldy in size or the speed increment would have to be increased above 10 per cent. In the P. & L. E. shops the speed increment was about 10 per cent. and the speed range required in the motor somewhat less than 3 to 1, the necessary number of runs of gears being used to give the total range in the machine. The maximum number of runs used was four.

Machine.	Cut: Feed Inches.	Cut: Depth Inches.	Speed Ft. per Min.	Weight Removed Lb. per M.	H. P.: Actual.	H. P.: From Formula.
60″ Planer No. 52	1/8 & 1/16	1/4 & 5/16	30	4.74	9.3	6.6
"	1/2	3/8 & 3/4	22.6	5.03	7.6	7.1
"	1/4	7/8 & 7/8	28.9	18.3	23.2	25.6
42″ Planer No. 55	1/16	1/16	37	4.06	4.7	5.7
"	1/16	1/8	37	2.71	4.1	3.8
"	1/8	1/16	40	1.46	2.6	2.1
72″ Boring Mill No. 29	1/16	3/8	28	2.05	2.6	2.9
"	1/8	1/8	33	1.07	1.4	1.5
"	1/16	1/4	39	1.90	2.7	2.7
42″ Lathe No. 10	1/16	3/8	108	2.63	5.8	3.7
"	1/16	1/16	46	1.74	2.9	2.5
"	1/16	1/8	58	2.12	2.2	3.0
"	1/16	1/16	45	1.64	1.9	2.3
30″ Lathe No. 20	1/32	1/16	42	1.92	3.0	2.7
"	1/32	1/16	61	1.12	1.5	1.6
"	1/64	1/4	47	2.30	2.0	3.2
"	1/32	1/4	55	1.34	2.0	1.9
					77.5	78.9

TABLE 4. POWER ABSORBED IN CUTTING CAST IRON.

Tool.	Description.	Builder.	Motor.
5	18″ by 8′ Lathe,	Flather & Co.	5 I, 5 H. P. CM
6	20″ by 8′ "	F. E. Reed Co.	5 I, 5 H. P. CM
7	20″ by 8′ "	F. E. Reed Co.	5 I, 5 H. P. CM
8	25″ by 6′ "	Putnam Machine Co.	7½ I, 7½ H. P. CM
10	42″ by 8′ "	Niles Tool Works Co.	15 I, 15 H. P. CM
11	24″ by 12′ "	American Tool Works Co.	7½ I, 7½ H. P. CM
13	Axle Lathe	Pond Machine Tool Co.	25 I, 25 H. P. CM
14	72″ Wheel Lathe	Niles Tool Works Co.	25 I, 25 H. P. CM
16	Turret Lathe	Jones & Lamson Machine Co.	5 I, 5 H. P. CM
16½	" "	Jones & Lamson Machine Co.	5 I, 5 H. P. CM
17	" "	American Tool & Machine Co.	3 I, 3 H. P. CM
18	" "	American Tool & Machine Co.	5 I, 5 H. P. CM
—	" "	Warner & Swasey Co.	5 I, 5 H. P. CM
19	24″ by 12′ Lathe	American Tool Works Co.	7½ I, 7½ H. P. CM
20	30″ by 15′ "	Putnam Machine Co.	10 I, 10 H. P. CM
21	Axle Lathe	Putnam Machine Co.	35 I, 35 H. P. CM
22	42″ Car Wheel Lathe	Pond Machine Tool Co.	20 I, 20 H. P. CM
23	90″ Wheel Lathe	Putnam Machine Co.	25 I, 25 H. P. CM
24	18″ by 10′ "	Putnam Machine Co.	7½ I, 7½ H. P. CM
25	36″ by 24′ "	Putnam Machine Co.	10 I, 10 H. P. CM
27	Hyd. Wheel Press, 200 ton	Niles Tool Works Co.	*7½ I, 7½ H. P. CCM
28	42″ Car Wheel Borer	Pond Machine Tool Co.	10 I, 10 H. P. CM
29	72″ Boring Mill	Pond Machine Tool Co.	25 I, 25 H. P. CM
30	100″ Hyd. Wheel Press	Putnam Machine Co.	*7½ I, 7½ H. P. CCM
31	18″ by 36″ Horizontal Boring Machine	Betts Machine Co.	15 I, 15 H. P. CM
32	84″ Quartering Machine	Niles Tool Works Co.	(2) 5 I, 5 H. P. CM
33	51″ Boring Mill	Baush Machine Tool Co.	15 I, 15 H. P. CM
37	36″ Drill Press		3 F, 4 H. P. CM
38	39, 40 & 41, same as No. 37		
43	72″ Radial Drill	Niles Tool Works Co.	3 F, 4 H. P. CM
46	Heavy Two Spindle Drill	Bement, Miles & Co.	(2) 7½ I, 9 H. P. CM
47	30″ Drill Press	J. E. Snyder	5 I, 5 H. P. CM
51	30″ by 30″ by 8′ Planer	New Haven Mfg. Co.	7½ I, 7½ H. P. CCM
52	60″ by 60″ by 20′ "	Pond Machine Tool Co.	20 I, 20 H. P. CCM
53	30″ by 30″ by 8′ "	Powell Planer Co.	7½ I, 7½ H. P. CCM
54	42″ by 42″ by 12′ "	Pond Machine Tool Co.	15 I, 15 H. P. CCM
55	42″ by 42″ by 12′ "	Cincinnati Planer Co.	15 I, 15 H. P. CCM
62	12″ Shaper	Hughes & Phillips	5 I, 5 H. P. CCM
63	24″ "	Gould & Eberhardt	7½ I, 7½ H. P. CCM
64	24″ Traversing Head Shaper	Cincinnati Shaper Co.	7½ I, 7½ H. P. CCM
67	20″ by 11′ Lathe	Putnam Machine Co.	7½ I, 7½ H. P. CM
68	20″ by 11′ "	Putnam Machine Co.	7½ I, 7½ H. P. CM
69	20″ by 11′ "	Putnam Machine Co.	7½ I, 7½ H. P. CM
70	34″ Gisholt Turret Lathe	Gisholt Machine Co.	15 I, 15 H. P. CM
71	Slab Miller	Wm. Sellers & Co.	5 I, 6¾ H. P. CCM
76	12″ slotter	Betts Machine Co.	5 I, 6¾ H. P. CCM
77	19″ "	Putnam Machine Co.	10 I, 13 H. P. CCM
91	6″ Pipe Cutter	D. Saunders' Sons	7½ I, 7½ H. P. CM
92	3″ " "	D. Saunders' Sons	3 I, 3 H. P. CM
—	(3) 18″ Emery Wheel Grinders	Bridgeport Emery Wheel Co.	3 D, 4 H. P. CM
125	Bending Rolls No. 2	Hilles & Jones Co.	7½ I, 7½ H. P. CCM
126	Bending Rolls No. 4	Hilles & Jones Co.	25 I, 25 H. P. CCM
127	Straightening Rolls No. 2	Hilles & Jones Co.	15 I, 15 H. P. CCM
130	Punch & Shear No. 3	Hilles & Jones Co.	*10 I, 10 H. P. CCM
131	Punch No. 2, with Spacing Table	Hilles & Jones Co.	10 I, 10 H. P. CCM
135	Punch 13-16″ Hole, 3-8″ Plate	Cleveland Punch & Shear W'ks Co.	*5 I, 5 H. P. CCM
136	Punch No. 5	Hilles & Jones Co.	*15 I, 15 H. P. CCM
137	Horizontal Punch	Hilles & Jones Co.	*10 I, 10 H. P. CCM
140	Shear No. 6	Hilles & Jones Co.	*15 I, 15 H. P. CCM
141	Angle Shear No. 1	Hilles & Jones Co.	*10 I, 10 H. P. CCM
147	60″ Radial Drill	Dreses Machine Tool Co.	5 I, 6¾ H.P. CM
167	Punch & Shears No. 4	Hilles & Jones Co.	15 I, 15 H. P. CCM

TABLE 5. TOOL LIST.

FORMULA FOR POWER REQUIRED.

Other conditions being the same, the power taken by a machine, after allowance is made for friction losses, will vary approximately as the speed and cut and therefore as the weight of metal removed, consequently in fitting motors to tools due allowance must be made for high speeds and maximum cuts, bearing in mind the coming universal use of high-speed tool steels and increase in rigidity of machines. A formula for amount of power absorbed in cutting may be stated thus:

$$HP = K\,W$$

where HP = Horse-power
K = A constant, depending on the kind and grade of material.
W = Weight of metal, pounds removed per minute.

Values of K may be taken as follows:

K = 2.5 for hard steel.
= 2.0 for wrought iron.
= 1.8 for soft steel.
= 1.4 for cast iron.

RESULTS COMPARED WITH THE FORMULA.

This formula is simply a general one. The power required in any particular case will vary perhaps 100 per cent. according to the condition of the cutting tool. To show how this formula applies examples are given in tables 1, 2, 3 and 4. These examples are taken at random from various machines tested and under ordinary conditions of shop working. They are not results of special tests. The machines, it will be noted, include several different types; some had one tool working, some two. The horse-power actually taken for the cut was obtained by deducting from the total power absorbed by the machine the power required to run the machine light at the same speed This is not quite correct in some cases, for example, in drilling as will be shown later.

There is considerable discrepancy in some of the figures. This is as might be expected, but in general the agreement is sufficiently close to show that the formula is a reasonable one for arriving at the approximate horse-power required for doing the actual work. The readings for hard steel are rather erratic. This is quite natural as the grade of steel in wheels varies widely; some of the material in that class should evidently be in the soft-steel class. The figures for the drill presses are also rather divergent. This is especially the case in drilling but not so much so in enlarging. The main reason for this is the inaccuracy of the light-load losses. The friction loss of the machine running idle is not the same as the friction loss when the machine is working. This friction loss should have been obtained by putting in a non-cutting drill and applying the pressure. In connection with the tables, it may be noted also that the readings for wrought iron are too few to be of any value.

FRICTION LOSSES.

Another factor which enters into the capacity of the motor required is the friction loss of the machine itself. This is a factor impossible to predetermine but fortunately is not very large except on very large machines; it depends greatly on the gear reduction. A few examples of friction losses will serve to show the general run of such losses; the power lost in other machines may be assumed by comparison.

Fig. 1 shows the power lost in friction in P. & L. E. tool No. 29, a 72-inch Pond boring mill. There is a difference in lost power in the different gear ratios ranging from 2.9 horse-power for the high-speed spindle to 0.5 horse-power for the low-speed spindle with motor running at the same speed, 800 revolutions

per minute. The spindle speeds for a loss of 0.5 horse power are 3.14, 4.22 and 1.86, respectively, showing that the loss in friction is not directly proportional either to motor speed or spindle speed. This holds true for all tools.

Fig. 2 is for tool No. 23, a 90-inch Putnam driving-wheel lathe. This is quite a large machine, but the friction loss is small, only 1.6 horse-power maximum for high spindle speed and 0.55 horse-power for low spindle speed. Although the gear reductions vary considerably—29 to 1 and 600 to 1—yet the total actual difference in lost power is not very large.

Fig. 3 is for a 20-inch by 11-foot Putnam lathe, gear reduction varying from 3-1 to 80-1. The maximum loss is about 1.2 horse-power.

Fig. 4 shows incidentally the power lost in a 60-inch planer, Figs. 6 and 7, in punches.

Similar curves could be given for a large number of machines, but these are sufficient to show the general trend of the losses, especially as they show that the losses are small, except when the spindle or table is running at top speed. At the high spindle speed it is rather unlikely that a maximum cut is to be taken, but in all probability only light finishing cuts or polishing, so that in general the power lost in friction in the machine may be neglected in considering the question of size of motor required.

RECIPROCATING TOOLS.

There is a class of machines where the size of motor required depends very largely on the machine itself, almost independent of the size of cut it has to take. This is the reciprocating tool, as the shaper and planer and to a somewhat less extent the intermittent working machines, such as punches and shears. In planers, where shifting of belts is relied on to reverse the motion, the statement is fairly accurate; in tools where the reversal takes place by magnetic clutches or motor reversal it is not so much so, as the power taken by the motor can be better regulated. In planer drives where motor runs continuously in one direction, it is of relatively little importance how much the platen or the load on it weighs, but the size and weight of the revolving pulleys which have to reverse it is of very great importance. These pulleys should be as small and light at the rim as capacity will allow; and on one of the revolving shafts, preferably on the motor shaft, there should be a fly-wheel of large diamter and heavy rim, so as to aid the motor at moment of reversal.

Fig. 4 is for machine No. 52, a 60-inch by 60-inch by 20-foot Pond planer. The cycle of power consumption is rather remarkable, but is a fair example of tools of this class and method of drive, reversal by shifting belts. These readings were taken with the machine running light. During cutting stroke the horse-power taken was 3.9, reversing to return stroke the power jumped to 19; on the return stroke it was 6.3 and in reversing to cutting stroke it rose to 27.0. Speed of the table in cutting stroke about 25 feet per minute; on the reverse stroke, 60 feet per minute. This planer was driven by a compound wound Crocker-Wheeler motor, 73.5 amperes, 20 horse-power at full speed and voltage rating. The fly-wheel on this machine is much too small, but owing to special design of the driving mechanism it could not be increased. The driving mechanism would have to be improved considerably to make it suitable for much higher speeds.

Fig. 5 is of some tests on a 36-inch by 36-inch by 12-foot Pond planer on exhibition at the St. Louis Exposition. This machine was driven by a reversing motor, belts being entirely done away with. The same general cycle is evident. Horse-power, 4.1, to 18.0, to 6.0, to 24.0 and back to 4.1. Speed of table cutting stroke was 32 feet per minute, return stroke 75 feet per minute. The horse-power in this curve includes the power losses in the motor itself, which are not included in any of the other cuts. This planer was driven by a No. 7 6-horse-power, type S, Westinghouse motor, speed change 4 to 1, rating 48 amperes at 110 or 220 volts. Loads obtained in taking heavy cuts were considerably in excess of the rating of the motor.

Influence of design on the power required for punches and shears is well brought out by Figs. 6 and 7. Each machine was used, for example, for punching a 1¼-inch hole in a 1¼-inch plate. In the lighter machine, No. 130, Fig. 6, the horse-power rose to 21, while in No. 167, Fig. 7, only to 7.9, showing very clearly the influence of the heavy fly-wheel and gear in the latter machine.

In the shops of the P. & L. E. R. R. Co., at McKees Rocks, there are about 80 machines driven by individual motors. For variable-speed work, the speed variation required in the motor was, in general, about 2.8 to 1 for full power, but up to from 6 and 7½ to 1 for diminished power at low speeds, and the size of motor was approximately double the horse-power required by the machine throughout this full power range, i. e., if the motor was rated as a variable-speed motor, it would have a rating approximately one-half that of the constant-speed rating. The speed variation in many instances differed considerably from the above. In many of the drills, the speed variation was higher and in planers, shapers, etc., lower. As has been brought out in previous papers read before this society, the speed control in these shops is obtained by means of the multi-voltage system. The horse-power required by the machine was determined partly by general considerations and partly by the formula stated above, $H\ P = KW$. where K had a value of 3.6 for hard steels and 2.5 for soft steels. From data given on previous pages, it may be seen that the size of this constant was on the safe side. All machines are protected by both circuit breaker and fuses, the size of the breaker was, in general, 4 amperes

MOTOR.					CUT.			MATERIAL.			REMARKS.
Controller Point.	Voltage.	Current.	R. P. M.	H. P. Input.	Feed Inches.	Depth Inches.	Speed Ft. per Min.	Diam. Inches.	Weight Pounds Min.	Kind.	
18	240	4	....	.....	.....	.....	....	....	.....	.....	Running light, table not turning
18	240	6	....	.....	.....	.....	....	....	.....	.....	" " table turning
18	....	20	785	.....	.125	.125 & .125	....	19.5	.....	Cast Iron	Two heads
21	233	28	970	8.76	.....	.....	.....	....	....	.....	Running light
21	233	38	978	11.88	.062	.094	47	7.5	0.99	Brass	
21	232	37	988	11.51	.0625	.0625	47	7.5	0.66	"	
4	76	38	243	3.77	.0625	.375	28	58	2.05	Cast Iron	
9	116	16	361	2.49	.....	.....	.....	....	.....	.....	Running light
8	76	49	340	4.98	.0625	.25	39	58	1.90	Cast Iron	
12	115	33	480	5.08	.125	.062 & .031	44	44	1.24	Steel	
10	114	28	473	4.27	.125	.0625	42	44	1.11	"	
13	160	19	519	4.07	.....	.....	.....	....	.....	.....	Running light
9	113	75	354	11.36	.125	.125 & .125	51	52	5.41	Steel	
9	112	95	349	14.26	.125	.187 & .187	48	52	7.65	"	
9	115	58	360	8.93	.125	.125 & .187	47	52	3.75	"	
17	195	25	684	6.54	.125	.125	80	19	4.50	Brass	
21	234	35	964	11.00	.125	.094 & .031	123	20	6.91	"	
20	235	30	915	9.47	.187	.031 & .016	115	20	3.64	"	
20	236	20	930	6.33	.....	.....	.....	....	.....	.....	Running light
20	244	13	940	4.25	.083	.125	33	18	1.07	Cast Iron	
6	78	26	294	2.72	.083	.125	33	18	1.07	"	
15	161	15	612	3.24	.062	.062	24	20	1.29	"	

TABLE 6. TESTS OF 72-INCH BORING MILL.

MOTOR.					CUT.			MATERIAL.			REMARKS.
Controller Point.	Voltage.	Current.	R. P. M.	H. P. Input.	Feed Inches.	Depth Inches.	Speed Ft. per Min.	Diam. Inches.	Weight Pounds Min.	Kind.	
16	188	60	637	15.1	1/16	1/16 & 1/16	13.0	48	3.1	Steel	Double Head
13	157	50	430	10.5	1/16	1/16 & 1/16	8.8	48	3.5	"	" "
16	190	70	650	17.8	1/16	1/8 & 1/8	13.3	48	4.2	"	" "
13	156	45	540	9.4	1/16	1/16 & 1/16	10.9	48	2.6	"	" "
13	156	75	537	15.7	1/16	1/8 & 1/8	12.3	54	6.3	"	" "
13	156	70	536	14.6	1/16	1/8 & 1/8	12.3	54	6.3	"	" "
9	113	80	355	12.1	1/16	1/16 & 1/16	10.5	69	4.0	"	" "
9	114	77	363	11.8	1/16	1/16 & 1/16	10.6	69	3.6	"	" "
11	115	60	450	9.1	1/16	1/16 & 1/16	13.4	71	4.0	"	" "
17	196	46	728	12.1	1/16	1/16 & 1/16	15.5	51	5.3	"	" "

TABLE 7. TESTS OF 90-INCH DRIVING WHEEL LATHE.

per rated horse-power of the motor and it was set at the limit of 50 per cent. above this rating, the breaker would therefore fly out when the power consumption was approximately 100 per cent. overload. On reciprocating tools, the circuit breaker was set 40 to 50 per cent higher. The enclosed fuses used had a rating the same as that at which the circuit breakers were set.

SIZES OF MOTORS USED.

The individual-motor-driven tools used in these shops and the size of motors are given in the tool list, Table 5. When the horse-power differs from the size of motor, it indicates that the motor is a high speed one. *CM* stands for shunt motor, *CCM* for compound. The letters *I*, *F*, and *D* after the initial number indicate type of frame. The number indicates the size and in every case is the same as the horse-power of the motor run at low speed, 230 volts. Motors marked with an asterisk (*) are constant speed; all others are used as variable-speed motors. All motors are the standard motors of the Crocker-Wheeler Company, and the ratings are for constant speed at 240 volts.

In addition to these individual-motor-driven tools there are ten groups of tools in the several shops. In the wood-working shops group driving in small groups is the rule. Group driving was used only where speed change was not required. There are at the plant about forty motors for other purposes than machine-tool driving, also eleven electric cranes.

TESTS OF MOTOR CAPACITY.

After the plant was in operation a

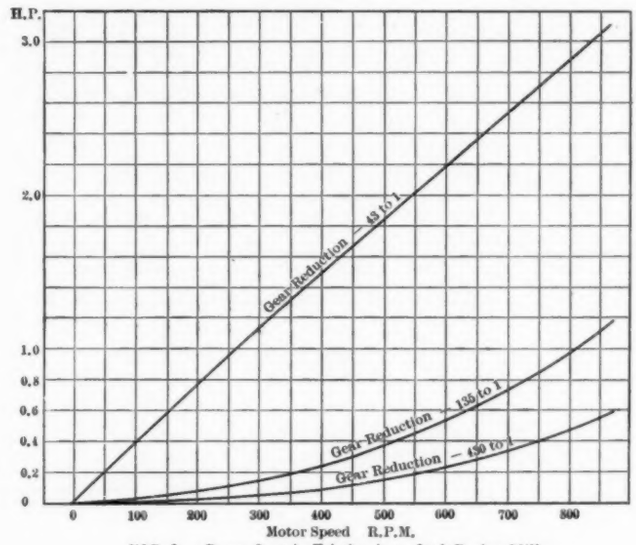


FIG. 1. — Power Lost in Friction in 72 Inch Boring Mill.

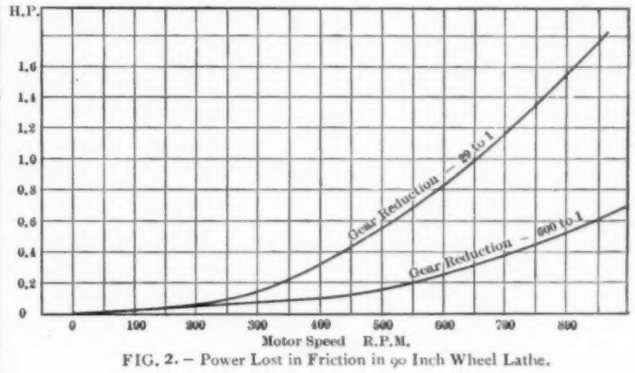


FIG. 2. — Power Lost in Friction in 90 Inch Wheel Lathe.

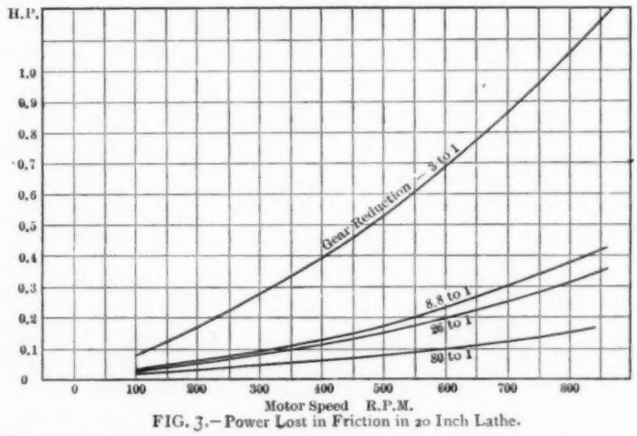


FIG. 3.—Power Lost in Friction in 20 Inch Lathe.

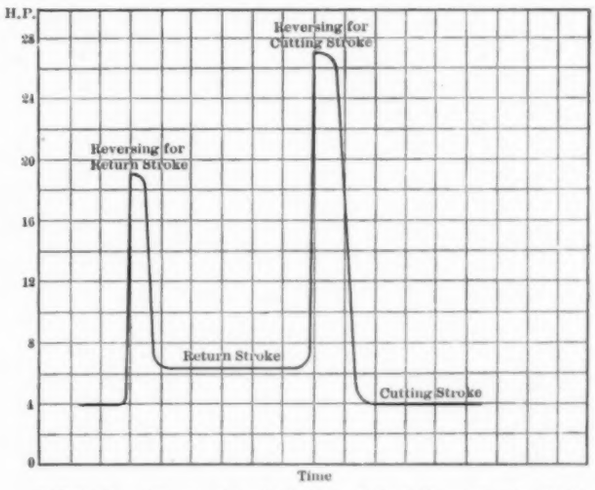


FIG. 4.—Power Consumption of 60″ x 60″ x 20′ Pond Planer, Running Light.

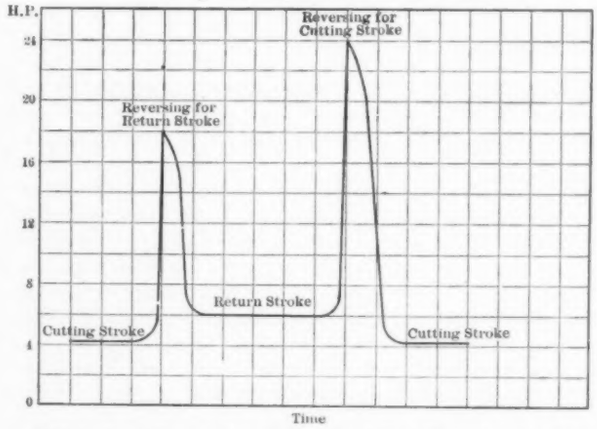


FIG. 5.—Power Consumption of 36″ x 36″ x 12′ Pond Planer, Running Light.

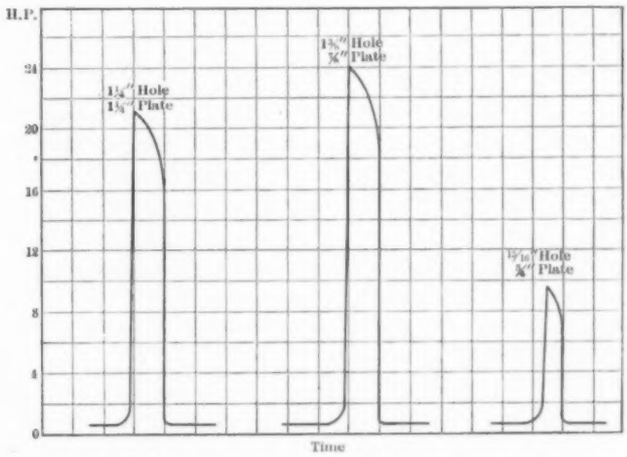


FIG. 6. — Power Consumption of Hilles & Jones Punch No. 3.

large number tests were made, every machine listed being tested to see whether or not the motor capacity was sufficient. In no case is the motor too small. In a few cases the motor could easily be reduced for P. & L. E. R. R. work; in general, the sizes are such as would be used providing the size of motors had to be fixed over again. Lathes Nos. 5, 6, 7, 16 and 16½ could be operated by a 3 horse-power motor instead of 5, lathe No. 14 with a 5 horse-power instead of 7½, but if the machine were used for heavier work than is supplied by these shops, the motors are none too large. Axle lathe No 21 could at present do with a 15 or 20 horse-power motor, instead of a 35, but the intention was to give sufficient capacity to allow axles to be received in the rough and to do all the rough turning; at present the axles are bought rough turned. Motor on punch and shears No. 130 is too small for punching larger than 1-inch hole in 1-inch plate but the machine should not be used for such work, although the manufacturers state it is good for punching 1½-inch hole in 1-inch plate; if so the fly-wheel should be very considerably increased.

In making tests three separate sets were made;

1st, power required to drive the motor disconnected entirely from the machine, the motor being run at all the speeds.

2d, power required to drive the machine on its different gear drives and different motor speeds.

3d, the total power required during the time the machine gear drives and different motor speeds.

This latter set of tests was taken haphazard, i. e., the electrician simply passed from machine to machine and took readings and record of the cut, no attempt being made to get the record at the best tool efficiency, consequently the records give everyday shop practice such as will probably be met with in the ordinary shop. Practically all the tests were made in 1904, not long after the new shops were running and consequently the cuts and speeds given are much lower than present-day practice, nor was any attempt made to make tests when the machines were taking heavy cuts. These points must be borne in mind if cuts and feeds are examined.

After the tests were made, the first set would be compared motor to motor to see if all motors were equally efficient, then the first set would be subtracted from the second to obtain friction losses in the various machines and finally the second set would be subtracted from the third to find the actual horse-power taken by the cutting tool or tools. The curves for the motors need not be reproduced, as the loss is on the input and not on output of the motor. The horse-power of the motor being brake horse-power, losses are allowed for by the manufacturers. The curve of power lost by friction is given for a few cases in Figs. 1, 2, 3, 4, 6 and 7, and the power taken by the cut is given in the general summary near the beginning of this paper. As a sample, however, of the tests made, Table 6 is given for the 72-inch boring mill, No. 29. The horse-power given is the input into the motor, not the horse-power of the cut. The horse-power lost by friction given in Fig. 1 and the power lost in the motor given in Fig. 8, must be subtracted to get the actual tool power consumption. The horse-power taken by the first two items, while working brass, is abnormal, the cutting tools must have had excessive negative rake, the two readings were evidently taken on the one job. The readings for cutting brass lower down the list are more like what would be expected.

Table 7 is of some of the readings taken on the 90-inch driving wheel lathe No. 23. After eliminating the power lost in friction given in Fig. 2 and in the motor, practically the same as in Fig. 8 the horse-power required to remove one pound of metal is given in Fig. 9; the amount varies from 3.87 to 1.70, certainly a very wide range but the grade of steel also varies widely.

TOTAL LOSS OF POWER.

The total power lost in the motors and lost in friction in the machines is considerable, even though in individual cases it is not very large. To investigate this point, among others, some experiments were made on a Sunday when the shops were idle. Forty-six machines were selected, every one equipped with an individual motor capable of speed variation. The machines were as follows:

	Machines.	Horse Power Rating of Motors.
17	Lathes	215
5	Milling Machines and Boring Mills	70
5	Planers	66
5	Slotters and Shapers	35
9	Drilling Machines	50
5	Punches, Shapers, Rolls, etc	61
46		497

First, full current strength was put on all the fields, then all the motors were run on the 40-volt circuit, then all on the 80-volt circuit, 120-volt, 160-volt, 200-volt and 240-volt in turn, and finally lathes and drills were run on the high-speed point, approximately 30 per cent. above normal 240-volt speed, power consumption being noted at all the different points. All machines driven by these motors were in motion but no work was being done, nor was feed mechanism in use. The results are tabulated in Fig. 10; planer platens were not operating except for points 3, 6, and 8. The curve giving losses in motor armatures was platted from readings on a number of motors disconnected from machines. The speed of the motors varies approximately as the impressed voltage, so it will be seen that after deducting 15.2 horse-power for the fields the horse-power lost in the motor armature and tool varies approximately as the speed. The full losses given are never incurred as the tools are never all running at one time and never all on the top motor speed. In fact the average or even the maximum power consumption on any working day when all the tools are working is less than the maximum for lost power alone. The part of curve at the right hand in the cut is the total power consumption for all the tools included above and a few constant-speed motors besides. These readings were taken every two hours during the six working days succeeding the Sunday on which the readings for power losses were taken.

A large number of special conditions may enter into the determination of the size of the motor required for any particular tool, the class of work it is to be re-

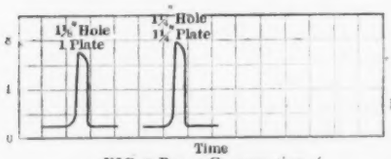


FIG. 7 Power Consumption of Hilles & Jones Punch No. 4

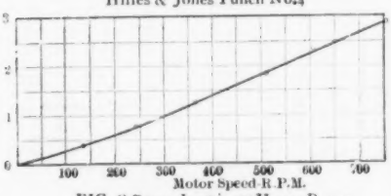


FIG. 8 Power Lost in 25 Horse Power Motor on Machine No. 29

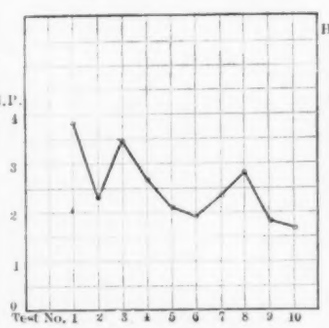


FIG. 9 Horse Power Required per Pound of Metal Removed

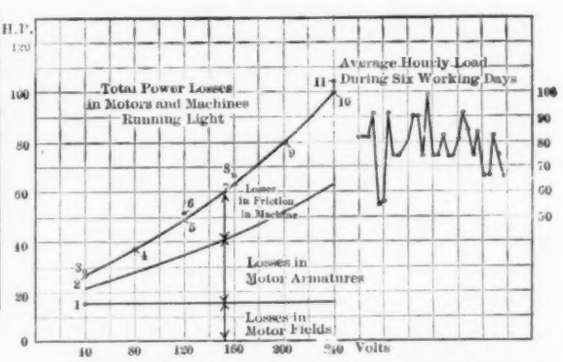


FIG. 10 Power Losses and Average Power Consumption of 46 Machines with Motors having an Aggregate of about 500 Rated Horse Power

stricted to, the grade of material, whether cuts, if heavy, will be of short duration etc., so that it is rather difficult to make a statement that will fit all cases, but the writer would suggest the following for determining size of motor for average conditions: Assume a cutting speed of 50 to 70 feet a minute for soft steels, estimate the maximum size of cut that will likely be required for any time longer than 30 minutes, transfer this into pounds of metal removed per minute and multiply by 2.7 (this figure is 50 per cent. above the constant 1.8 used previously in this paper, the increase being for safety for bad conditions), then select a motor which will develop this power throughout the range of speed desired.

The record is not quite complete as it does not give the gear reductions in use. Some of the machines were using high-speed, some low-speed gears. If all the machines had been run on the highest-speed gear the loss in friction in the machines would probably have been doubled.

Legal Notes.

BY E. P. BUFFET.

DELIVERY OF GOODS; JUDICIAL COGNIZANCE.

If in a contract for the sale of goods —weighing scales—it is stipulated that they be shipped "f.o.b." a certain place, addressed to the purchaser, the delivery to the carrier, free on board the car, addressed to the purchaser as provided in the contract, with notice to him of the shipment, is in effect a delivery to him. The court says, "We judicially know that 'f.o.b.' in such connection means free on board."

Appellate Court of Indiana, 76 N. E. Rep. 271.

WHETHER COTTON PELLETS OPENED A DOOR.

A card tender in a textile mill was injured by putting his hand through a door in the cover of the main carding cylinder. He was removing the waste which fell as a veil so as to obscure the fact that the door was open. The company contended that the door must have been left open by a fellow employee. The card tender claims that the card clothing on the cylinder had been crushed some two years before by a hoop of iron running through it, in consequence of which, he alleges, hard pellets of cotton were formed and thrown against the door with such force as to open it, which the company contends to be physically impossible. The jury returned a verdict for the injured man, and the Supreme Court refuses to overrule the exceptions thereto. The case involved a good deal of technical description and expert testimony on such physical principles as centrifugal force. It reaches the appeal court in such form that its merits are not fully passed upon, but it is merely decided that in view of the evidence, the court would not be warranted in holding, as a matter of law, that the pellets could not have opened the door.

Massachusetts Supreme Court, 76 N. E. Rep., 235.

LATHE ACCIDENT IN COILING A SPRING.

A recent case in Massachusetts was based on injuries received by a workman while winding springs on a lathe for a spring company. It appeared that he had already had considerable experience in the actual coiling but had never before "set up the machine." This involved chucking in a lathe an arbor about 10 ft. long. Upon the arbor before it is placed in position, a "guide" is adjusted, which is a piece of iron about 30 in. long by 3 in. in width, with a brace on the back at one end. Through the brace and this end of the guide is an "arbor hole" in which the arbor runs. There is a set-screw on the left side of the guide facing the machine, over which the wire passes while being wound. Both arbor and guide are changed according to the size of the wire used, and it is the duty of the person setting the machine to select and change the guide. If the arbor hole is too large, the arbor will shake or vibrate, tending to make the wire bend and slip off the setting screw. One day the workman in question was directed by the man in charge to set the machine for himself, and spent, according to the evidence, 6½ hours at it, whereas an experienced man might have done it in 15 or 20 minutes. When he came to use the machine the arbor shook, he put his hands on guide and wire to calm it, the wire slipped off the set-screw, caught his arm and pulled it around the arbor. He claims that the guides, one of which he selected, were all worn. The case is a mixed one in which inexperience, safety of appliances, alleged failure to give suitable instructions, assumption of the risk and authority of the man who seemed to be in charge are bones of contention. The jury found for the injured man, and the appeal court, while not determining whether or not they weighed the evidence justly, does not see ground, as a matter of law, for disturbing the verdict.

76 N. E. Rep., 220.

WARNING REQUIRED IN HAZARDOUS EMPLOYMENT.

Slag, accumulated in a blast furnace, which had been taken down, was being dynamited. Incased in the slag was a coil of iron pipe, which was being filled with the explosive, and O'B., an employee of the furnace company, was called on to assist by cutting up a stick of the material and dropping it into the pipe. It appears that he hesitated, and that both the foreman and general manager assured him that there was no danger. While O'B. dropped the pieces into the pipe, M., a fellow-employee in charge of the work, as the pieces clogged or adhered to the sides, pushed them down with a steel rod some six feet long. Suddenly O'B.'s dynamiting days terminated. His administratrix sued the company for damages and lost the case. It was carried up to the New York Appellate Division, 4th Dept., with the same result. The Court of Appeals, however, has reversed the judgment of the lower tribunals.

This highest court holds that the duty of an employer to warn a workman of the latent danger of an employment does not readily apply to so obvious a hazard as the use of dynamite, and even the statements of the foreman and superintendent [or general manager] that there was no danger seem mere expressions of opinion which the deceased might accept or reject as he deemed wise. Nor did the negligence of the fellow workman M., in using a steel rod instead of a wooden stick, constitute negligence on the part of the company. Yet there was a further circumstance by which the company might be held liable. It appeared that the general manager had noticed the use of the steel rod, had been aware of its danger and had failed to warn the man who was using it. This was a point on which he should have given warning and in failing to do which he (contrary to the view of the Appellate Division) acted as a representative of the company so that it was chargeable with his omission. It seems indeed to be the court's opinion that so far as the relations between the company's representative and O'B. were concerned, even a caution to M. which he was at liberty to disregard would hardly have sufficed. It might have been the duty to discharge him summarily unless he thereafter prosecuted the work in a safe manner. A new trial has been ordered.

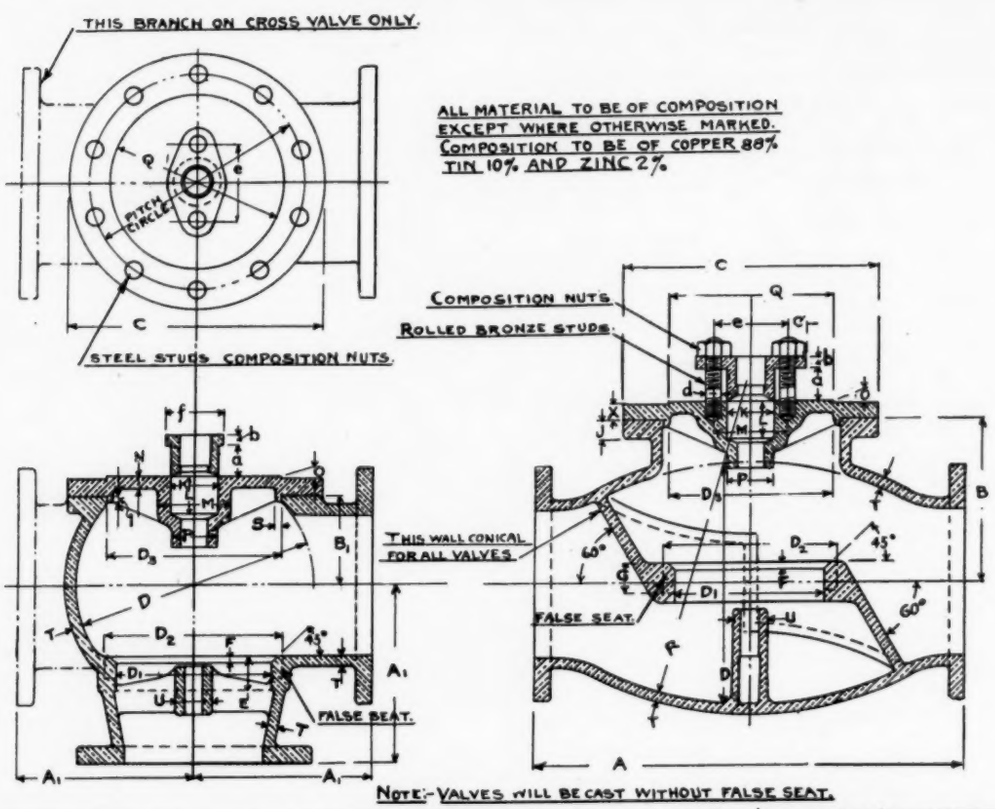
76 N. E. Rep., 161.

The University of Wisconsin has recently purchased from the General Electric Company a 25-kilowatt, horizontal type Curtis steam turbine for the instruction of students and for experimental purposes. Owing to the increasing importance of this type of machine in electrical plants as well as the recent successful application for ship propulsion, the college of engineering considers itself particularly fortunate in securing this addition to its laboratory equipment.

Globe Valve Standards.

BY. A. H. NOURSE.

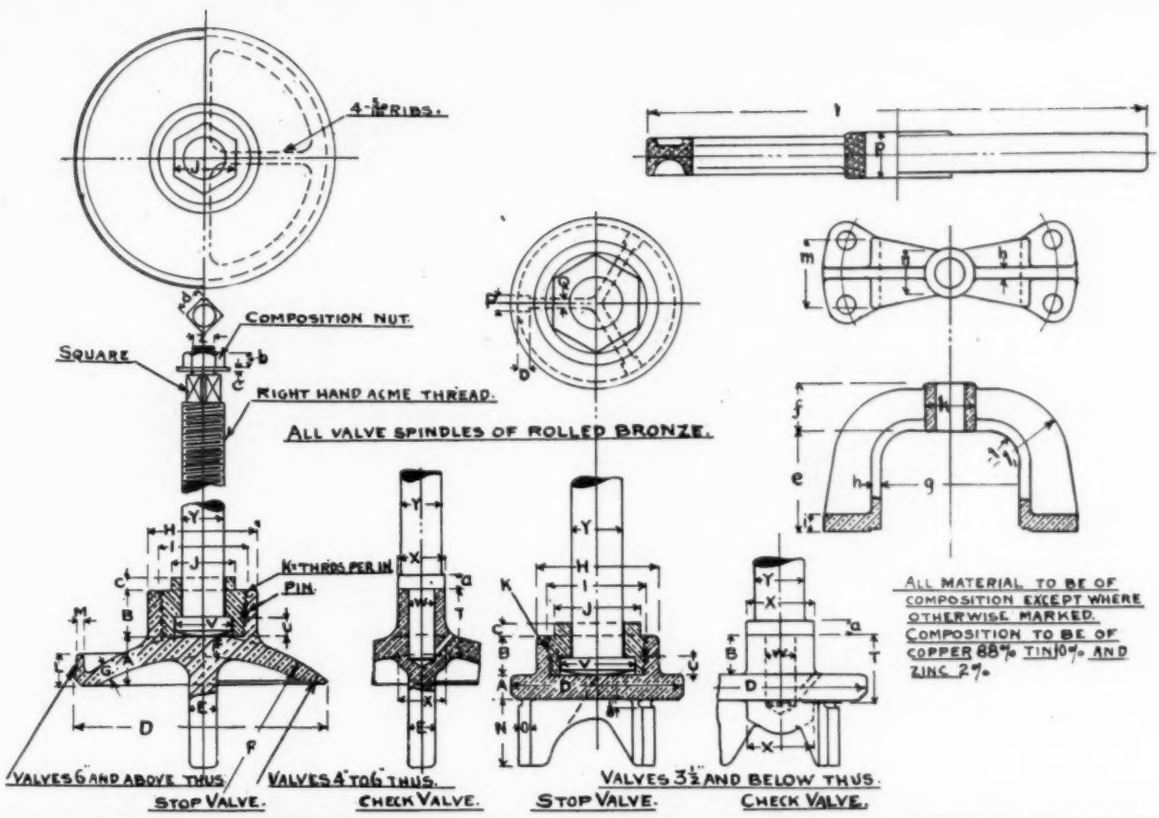
The tables for low-pressure and heavy-pressure valves and hand-wheels show a type which has been adopted by all the large shipbuilding firms of the country. While the dimension *A* may give a somewhat longer valve than might appear necessary, it has been found that in using this valve in a line of steam piping, it gives a more satisfactory flow than would be obtained by one of a contracted form.


THIS BRANCH ON CROSS VALVE ONLY.
ALL MATERIAL TO BE OF COMPOSITION EXCEPT WHERE OTHERWISE MARKED. COMPOSITION TO BE OF COPPER 88% TIN 10% AND ZINC 2%.
PITCH CIRCLE
STEEL STUDS COMPOSITION NUTS.
COMPOSITION NUTS.
ROLLED BRONZE STUDS.
THIS WALL CONICAL FOR ALL VALVES.
FALSE SEAT.
FALSE SEAT.
60°
45°

NOTE:- VALVES WILL BE CAST WITHOUT FALSE SEAT.

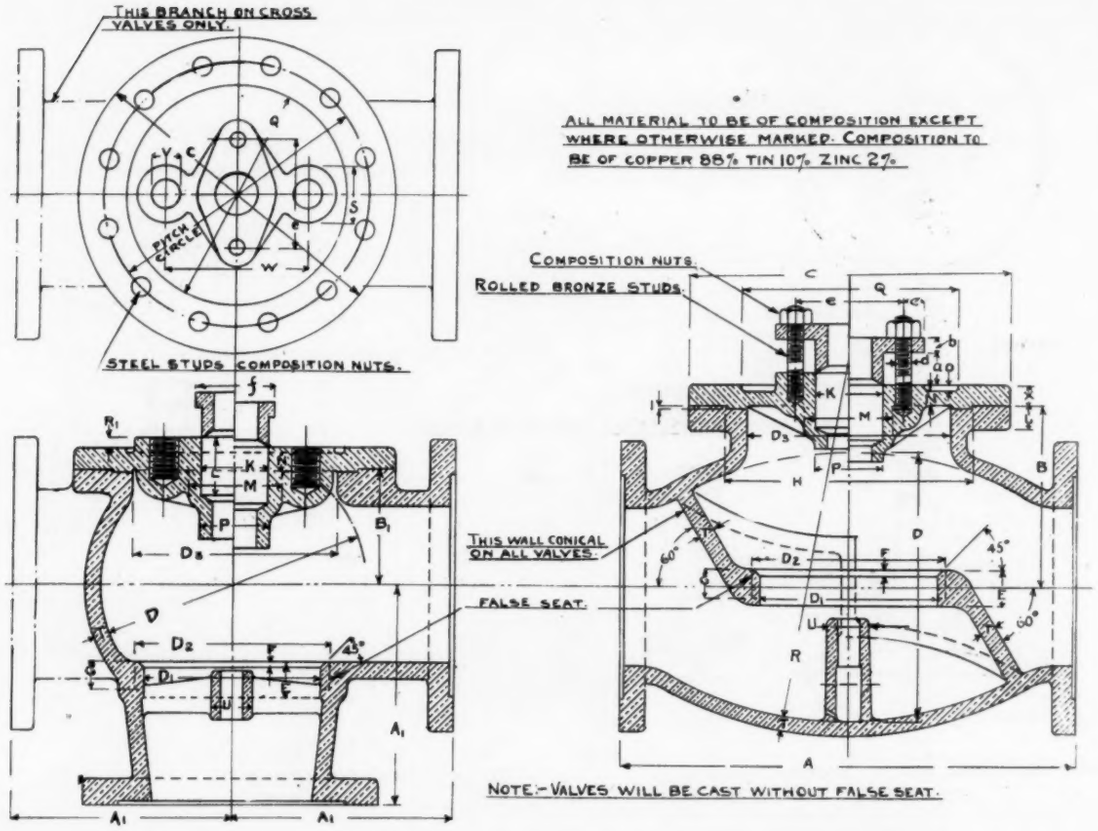
SIZE OF VALVE.	A	B	A_1	B_1	C	D	D_1	D_2	D_3	E	F	G	I	J	K	L	M	N	O	P	Q	R	S	T	U	X	PITCH CIRCLE	NO. OF STUDS IN COVER	SIZE OF STUDS IN COVER	NO. OF STUDS IN BODY	SIZE OF STUDS IN BODY	NO. OF STUDS IN FALSE SEAT	SIZE OF STUDS IN FALSE SEAT	a	b	c	d	e	f
1/2	6		3				5/8	—				—												5/32	—				—	—	—	—						
3/4	7		3 1/2				7/8	—				—												3/16	—				—	—	—	—						
1	7 1/2	11 1/4	3 3/4	1 1/16	4	2 3/4	1 1/8	—	1 1/4		1/16	—	1/8	7/16	1/8							3 3/16	3/16	3/16	—	3/8	2 7/8	6	3/8	—	—	—	—						
1 1/4	8 1/2	12 3/8	4 1/4	1 1/8	4 1/2	3	1 3/8	—	2		1/16	—	1/8	7/16	1/8							4	3/16	3/16	—	3/8	3 1/8	6	3/8	—	—	—	—						
1 1/2	8 3/8	12 1/2	4 3/8	1 3/8	5	3 1/2	1 3/4	—	2 3/8		1/16	—	1/8	1/2	1/8							4 3/16	3/16	3/16	—	3/8	3 1/4	6	1/2	—	—	—	—						
2	10 1/4	12 3/4	5 1/8	1 3/8	5 1/2	4	2 1/4	—	2 3/4		1/16	—	1/8	1/2	1 1/8	1 1/4	1 1/8	1 1/2	1 1/8	3 1/8	6	3/16	3/16	3/16	—	7/16	4 3/8	6	1/2	—	—	—	—	3/8	7/16	1/2	7/16	2 1/8	1 1/8
2 1/2	11 1/2	13	5 3/4	1 1/2	6 1/8	4 3/4	2 1/2	—	3 1/8	7/8	1/16	—	1/8	9/16	1 1/2	1 1/4	2	5/16	1/16	1 1/4	3 1/8	6 3/8	3/16	3/16	—	7/16	4 7/8	6	1/2	—	—	—	—	3/8	7/16	9/16	1/2	2 1/16	1 1/4
3	12 1/2	13 3/4	6 1/4	1 2/8	7 1/8	5 1/2	3 1/8	—	4	7/8	1/8	—	3/16	9/16	1 1/2	1 1/4	2	5/16	1/16	1 1/4	4 1/8	7 1/4	3/16	1/4	—	7/16	5 3/4	6	5/8	4	5/16	—	—	1	7/16	9/16	1/2	2 7/16	1 1/4
3 1/2	13	14 1/4	6 1/2	1 2/16	7 3/8	6 1/8	3 3/4	—	4 1/2	1	1/8	—	3/16	5/8	1 3/4	1 3/8	2 3/8	5/16	1/16	1 1/2	4 5/8	8 5/8	5/16	1/4	—	1/2	6 1/4	6	5/8	4	5/16	—	—	1	1/2	9/16	1/2	2 3/4	2
4	13 3/4	14 3/4	6 7/8	2 1/16	8 3/8	7 1/8	4 1/2	—	5 1/8	1	1/8	—	3/16	5/8	1 3/4	1 3/8	2 3/8	5/16	1/16	1 1/2	5 1/8	9 3/8	5/16	1/4	1 1/8	1/2	6 3/8	6	5/8	4	5/16	3	1/4	1	1/2	9/16	1/2	2 3/4	2
4 1/2	15	15 1/4	7 1/2	3	9 1/8	8	5 1/2	6	1/16	1/8	3/16	1/16	1/4	11/16	1 7/8	1 1/2	2 1/2	3/8	1/16	1 5/8	5 3/8	10 1/4	5/16	1/4	1 1/8	1/2	7 1/4	8	5/8	4	5/16	3	1/4	1 1/8	1/2	9/16	1/2	2 1/8	2 1/8
5	16	15 3/4	8	3 1/4	9 5/8	8 3/4	5 1/2	6 1/4	6 3/8	1 1/8	1/8	1/8	1/4	3/4	1 7/8	1 1/2	2 1/2	3/8	1/16	1 5/8	6 1/4	11 1/8	5/16	1/16	1 1/2	1/2	8	8	5/8	4	3/8	3	3/8	1 1/8	1/2	9/16	1/2	2 1/8	2 1/8
5 1/2	16 3/8	16 1/4	8 1/8	3 1/2	10 1/4	9 1/2	6	6 7/8	7	1 1/4	1/8	1/16	5/16	3/4	2	1 1/2	2 5/8	3/8	1/16	1 3/4	6 1/2	12 1/4	5/16	5/16	1 1/2	1/2	8 3/8	10	5/8	4	3/8	3	3/8	1 1/8	3/4	5/8	3	2 1/4
6	18	16 3/4	9	3 3/4	11	10 1/4	6 1/2	7 1/8	7 1/2	1 1/4	1/8	1	1/4	3/4	2	1 5/8	2 5/8	7/16	1/16	1 3/4	7 1/8	13 1/4	1/2	5/16	1 1/2	1/2	9 1/2	10	5/8	4	3/8	3	3/8	1 1/4	3/4	5/8	3	2 1/4
6 1/2	18 3/8	17 1/8	9 1/4	4 1/8	11 3/8	11	7 1/8	8	8 1/4	1 3/8	1/8	1 1/16	1/4	3/4	2 1/8	1 5/8	2 3/4	7/16	1/16	1 7/8	7 1/2	14 3/8	1/2	5/16	1 3/4	5/8	10 1/4	12	5/8	4	3/8	3	3/8	1 1/4	3/4	5/8	3 1/2	2 1/2
7	20	18	9 5/8	4 3/8	13 1/8	11 7/8	7 1/2	8 3/8	9	1 1/2	1/8	1/8	1/4	7/8	2 1/8	1 5/8	2 3/4	7/16	1/16	1 7/8	8 5/8	15 1/2	1/2	3/8	1 3/4	5/8	11 1/2	12	3/4	4	1/2	3	1/2	1 1/4	7/8	3/4	3 1/2	2 1/2
7 1/2	21 1/2	18 3/8	10	4 5/8	13 1/2	12 3/8	8 1/4	9 1/8	9 1/4	1 1/2	1/8	1/4	1/4	7/8	2 3/8	1 3/4	3	7/16	1/16	2	8 1/2	16 3/8	1/2	3/8	1 3/4	11/16	11 3/4	12	3/4	4	1/2	3	1/2	1 3/8	7/8	3/4	3 1/2	2 3/4
8	22 3/8	19 1/8	10 3/8	5	14 1/4	13 1/2	9	9 7/8	10	1 5/8	1/8	1 5/16	1/4	7/8	2 3/8	1 3/4	3	1/2	1/16	2	9	17 5/8	1/2	3/8	2 1/8	3/4	12 1/2	14	3/4	4	1/2	3	1/2	1 3/8	7/8	3/4	3 1/2	2 3/4
8 1/2	24	19 3/8	10 3/4	5 1/2	14 7/8	14 1/4	9 1/2	10 1/8	10 3/8	1 3/4	1/8	1 5/16	1/4	7/8	2 1/2	1 3/4	3 1/2	1/2	1/16	2 3/8	9 1/2	18 3/4	1/2	3/8	2 1/8	3/4	13 1/8	14	3/4	4	1/2	3	1/2	1 3/8	7/8	3/4	3 1/2	2 7/8
9	25 1/2	20 1/8	11 1/4	5 1/2	15 3/8	15	10	11	11 1/8	1 7/8	1/8	1 3/8	1/4	15/16	2 1/2	1 7/8	3 1/2	1/2	1/16	2 5/8	10	20	1/2	7/16	2 3/8	13/16	13 3/8	14	3/4	4	1/2	3	1/2	1 3/8	7/8	3/4	3 1/2	2 7/8
9 1/2	26 3/8	20 3/8	11 5/8	5 7/8	16	15 3/8	10 1/2	11 1/2	11 3/4	1 7/8	1/8	1 7/16	1/4	15/16	2 3/4	2	3 3/8	1/2	1/16	2 3/4	10 1/2	21	1/2	7/16	2 3/8	13/16	14 3/8	16	3/4	4	1/2	3	1/2	1 1/2	7/8	3/4	4 1/4	3 1/8
10	28	21 1/4	12	6 1/8	16 3/8	16 1/2	11	12	12 1/8	2	1/8	1 1/2	1/4	15/16	2 3/4	2	3 3/4	5/8	1/16	2 3/4	11	22	1/2	7/16	2 3/8	7/8	14 7/8	16	3/4	4	1/2	3	5/8	1 1/2	7/8	3/4	4 1/4	3 1/8
10 1/2	29 1/8	21 3/4	12 1/2	6 3/8	17 1/4	17 1/4	11 1/2	12 1/2	12 3/4	2	1/8	1 1/2	1/4	15/16	2 3/4	2	3 7/8	5/8	1/16	2 7/8	11 1/2	23	1/2	7/16	2 3/8	7/8	15 3/4	18	3/4	4	1/2	3	5/8	1 1/2	7/8	3/4	4 3/8	3 1/8
11	30 1/2	22 1/8	13	6 3/8	17 3/4	18	12	13	13 1/4	2	1/8	1 1/2	1/4	1	2 7/8	2 1/4	3 7/8	5/8	1/16	2 7/8	12	24	1/2	1/2	2 3/8	7/8	16	18	3/4	4	1/2	3	5/8	1 1/2	7/8	3/4	4 3/8	3 1/4
11 1/2	31 1/2	22 3/8	13 1/4	6 3/8	19	18 1/2	12 1/2	13 3/8	13 3/4	2 1/8	1/8	1 5/8	1/4	1	3	2 1/4	4	5/8	1/16	3	12 1/2	25	1/2	1/2	2 3/8	7/8	17	18	7/8	4	1/2	3	5/8	1 5/8	7/8	3/4	4 1/2	3 3/8
12	33	23	13 3/8	7/8	19 3/8	19 1/2	13	14 1/4	14 3/8	2 1/8	1/8	1 5/8	1/4	1	3	2 1/2	4	11/16	1/16	3	13	26	1/2	1/2	2 3/8	7/8	17 7/8	18	7/8	4	5/8	4	5/8	1 5/8	7/8	3/4	4 1/2	3 3/8
12 1/2	34 1/8	23 3/8	14 1/4	7/8	20 1/8	20 1/4	13 3/8	14 3/8	14 3/8	2 1/8	1/8	1 5/8	1/4	1	3 1/4	2 1/2	4 1/2	11/16	1/16	3 3/8	13 1/2	28	1/2	1/2	2 3/8	7/8	18 1/8	20	7/8	4	5/8	4	5/8	1 5/8	7/8	3/4	4 5/8	3 5/8
13	36	23 3/4	14 3/8	7/8	20 3/8	21	14 1/8	15 1/8	15 3/8	2 1/4	1/8	1 3/4	1/4	1	3 3/8	2 3/4	4 5/8	11/16	1/16	3 1/4	14	28 1/8	1/2	9/16	2 3/8	7/8	18 3/8	20	7/8	4	5/8	4	5/8	1 5/8	7/8	1	4 5/8	3 3/4
13 1/2	37 1/8	24 1/8	14 3/8	15/16	21 1/8	21 3/4	14 5/8	15 3/8	15 3/8	2 1/4	1/8	1 3/4	1/4	1	3 1/2	2 3/4	4 3/4	3/4	1/16	3 3/8	14 1/2	29	1/2	9/16	2 3/8	7/8	19 1/8	20	7/8	4	3/4	4	5/8	1 5/8	7/8	1	4 5/8	3 3/4
14	39	24 1/2	15 3/8	8/8	21 7/8	22 3/4	15 1/4	16 3/8	16 3/8	2 1/4	1/8	1 3/4	1/4	1	3 1/2	3	4 3/4	3/4	1/16	3 3/8	15	31	1/2	5/8	2 3/8	7/8	19 7/8	20	7/8	4	3/4	4	5/8	1 5/8	7/8	1	4 5/8	3 3/8
14 1/2	40 1/2	25	16 1/4	8/8	22 3/8	23 1/4	15 3/4	16 3/8	17 1/8	2 1/4	1/8	1 3/4	1/4	1	3 5/8	3	4 7/8	3/4	1/16	3 1/2	15 1/2	32	1/2	5/8	2 3/8	7/8	20 3/8	20	7/8	4	3/4	4	5/8	1 5/8	7/8	1	4 5/8	4
15	42	25 1/2	16 3/4	9	22 3/4	24	16 1/4	17 3/8	17 1/2	2 1/4	1/8	1 3/4	1/4	1	3 5/8	3	4 7/8	3/4	1/16	3 1/2	16	33	1/2	5/8	2 3/8	7/8	20 3/8	22	7/8	4	3/4	4	5/8	1 5/8	7/8	1	4 5/8	4

LOW PRESSURE VALVES. LIMIT OF WORKING PRESSURE 100 POUNDS.



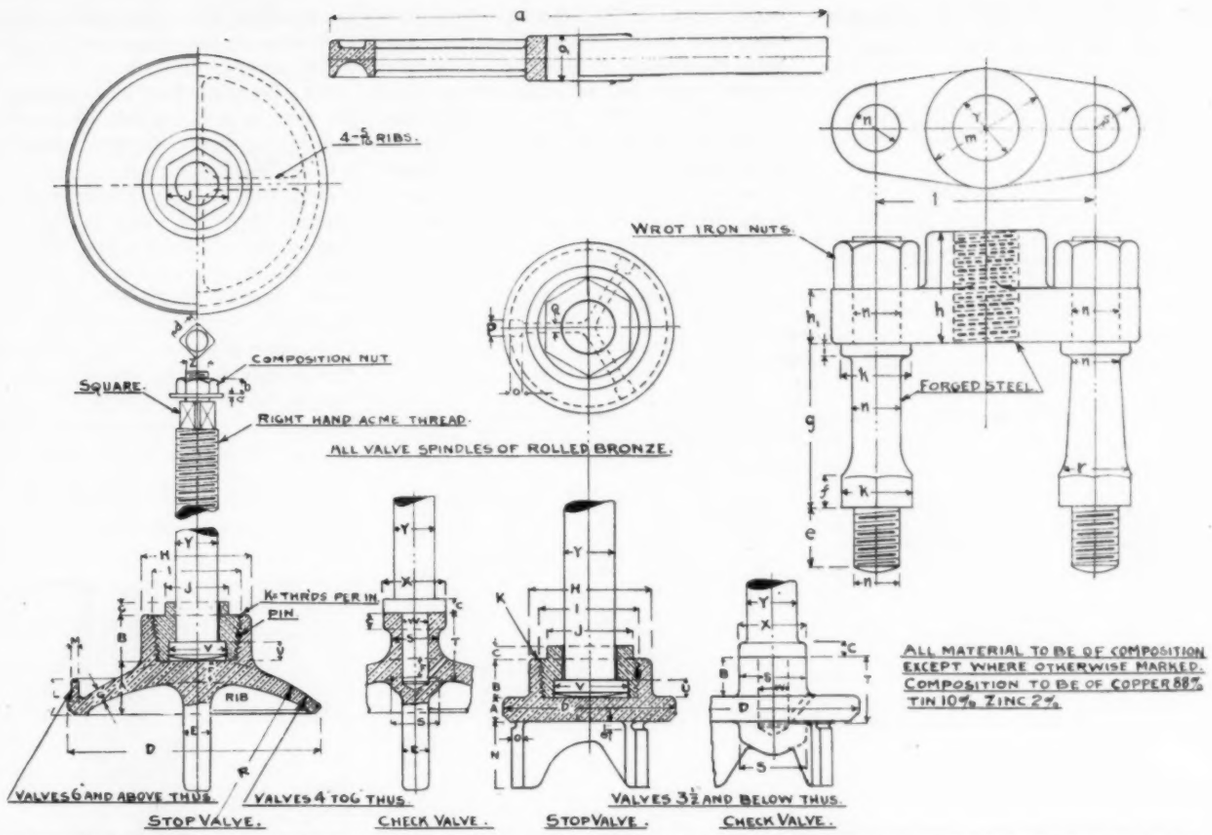
SIZE VALVE.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	T	U	V	W	X	Y	Z	THDS SPINDLE	a	b	c	d	e	f	g	h	i	k	l	l	m	n	p	r
1/2	1/4			13/16	—	—	—					—	—					—						3/8		9			—											3/8	2
3/4	1/4			1 1/16	—	—	—					—	—					—						1/2		8			—											7/16	3
1	1/4	1/2	5/16	1 3/8	—	—	—				16	—	—	5/8	1/8	3/16	1/8	—	11/16	1/8	13/16	3/8		5/8	5/16	7	5/16	1/4	—	3/8	1 1/8	1		1/4	3/8	1 3/8	3/8	1 1/4	1 1/4	1 3/8	7/16	3
1 1/4	5/16	1/2	3/16	1 7/8	—	—	—				16	—	—	3/4	1/8	3/16	1/8	—	3/4	3/16	15/16	3/8		5/8	5/16	7	5/16	1/4	—	3/8	2	1		1/4	3/8	1 3/8	3/8	1 1/4	1 3/8	1 1/4	1/2	4
1 1/2	5/16	1/2	3/16	2	—	—	—				16	—	—	3/4	1/8	3/16	1/8	—	13/16	1/4	1 1/16	3/8		3/4	3/8	6	3/16	5/16	—	7/16	2 1/16	1 1/8		1/4	7/16	1 1/2	3/8	1 3/8	1 1/2	1 1/4	1/2	4
2	5/16	1/2	3/16	2 1/2	—	—	—	2 1/8	1 5/8	1 1/4	14	—	—	1	3/16	1/4	3/8	—	15/16	5/16	1 1/8	1/2	1 1/16	3/4	3/8	6	3/16	5/16	—	7/16	2 3/8	1 1/8	2 3/8	1/4	7/16	1 1/2	3/8	1 3/8	1 1/2	1 5/16	5/8	5
2 1/2	5/16	5/8	1/4	3 1/8	—	—	—	2 3/8	1 3/4	1 7/16	14	—	—	1 1/8	3/16	1/4	3/8	—	1 1/8	5/16	1 1/4	1/2	1 1/16	7/8	1/2	6	1/4	3/8	—	9/16	2 1/2	1 3/8	2 7/8	1/4	7/16	1 3/4	1/2	1 3/4	1 5/8	1 1/8	11/16	6
3	7/16	3/4	1/4	3 3/4	—	—	—	2 1/2	1 7/8	1 5/8	14	—	—	1 3/8	1/4	1/4	3/8	—	1 1/4	3/8	1 1/4	5/8	1 1/4	7/8	1/2	6	1/4	3/8	—	9/16	2 3/4	1 3/8	3 1/4	1/4	7/16	1 3/4	5/8	1 7/8	1 3/4	1 5/8	1 1/16	6
3 1/2	1/2	3/4	1/4	4 1/8	—	—	—	2 1/2	1 7/8	1 5/8	14	—	—	1 1/2	1/4	1/4	3/8	—	1 3/8	3/8	1 1/2	5/8	1 1/4	1	1/2	5	1/4	3/8	—	9/16	3	1 3/8	3 1/4	1/4	1/2	1 7/8	3/4	2 1/4	1 7/8	1 1/2	3/4	7
4	1 1/8	7/8	1/4	4 3/8	3/4	3/8	3/8	2 3/4	2	1 5/8	14	—	—	—	—	—	—	4	1 1/2	3/8	1 1/2	3/4	1 3/8	1	1/2	5	1/4	3/8	—	9/16	3 3/8	1 5/8	4 1/4	1/4	1/2	1 7/8	7/8	2 3/8	1 7/8	1 1/2	7/8	8
4 1/2	1/4	7/8	1/4	5 1/8	3/4	3/8	3/8	3	2 1/4	2	12	—	—	—	—	—	—	4 1/2	1 5/8	3/8	1 5/8	3/4	1 3/8	1 1/8	5/8	5	1/4	1/2	—	11/16	3 3/8	1 7/8	4 5/8	1/4	1/2	2	1 1/8	2 1/4	2 1/8	1 5/8	7/8	8
5	1 5/16	1	3/8	5 1/8	7/8	3/8	3/8	3	2 1/4	2	12	—	—	—	—	—	—	5	1 13/16	3/8	1 5/8	7/8	1 5/8	1 1/8	5/8	5	3/8	1/2	—	11/16	3 7/16	1 7/8	5 1/8	5/16	9/16	2	1 1/8	2 1/8	2 1/8	1 5/8	15/16	9
5 1/2	1 3/8	1	3/8	6 1/8	7/8	7/16	3/8	3 3/8	2 1/2	2 1/8	12	—	—	—	—	—	—	5 1/2	1 7/8	7/16	1 7/8	7/8	1 5/8	1 1/4	5/8	4	3/8	1/2	—	3/4	3 3/4	2	5 1/2	5/16	9/16	2 1/8	1 1/4	3	2 1/8	1 3/8	1	10
6	1 1/2	1 1/8	3/8	6 3/8	7/8	1/2	3/8	3 3/8	2 1/2	2 1/8	12	1	3/8	—	—	—	—	6	2	7/16	1 7/8	7/8	1 5/8	1 1/4	5/8	4	3/8	1/2	—	3/4	4	2	6	3/8	5/16	2 1/8	1 3/8	3 1/8	2 1/4	1 3/4	1	10
6 1/2	1 1/2	1 1/4	3/8	7 1/8	1	1/2	7/16	3 3/4	2 7/8	2 9/16	12	1	3/8	—	—	—	—	6 1/2	2 1/16	1/2	2	1	1 3/4	1 3/8	3/4	4	3/8	1/2	—	13/16	4 1/4	2 3/8	6 1/2	3/8	5/8	2 3/8	1 1/2	3 3/8	2 1/4	2	1 1/16	11
7	1 5/8	1 3/8	1/2	8 1/4	1	1/2	7/16	3 3/4	2 7/8	2 9/16	12	1 1/8	3/8	—	—	—	—	7	2 5/16	1/2	2	1	1 3/4	1 3/8	3/4	4	1/2	1/2	—	13/16	4 3/8	2 3/8	6 7/8	3/8	5/8	2 3/8	1 3/4	3 3/8	2 3/8	2	1 1/8	12
7 1/2	1 11/16	1 1/2	1/2	8 3/4	1	5/8	7/16	4	3 1/8	2 3/4	12	1 1/8	7/16	—	—	—	—	7 1/2	2 1/2	9/16	2 1/4	1	1 7/8	1 1/4	3/4	4	1/2	1/2	—	15/16	4 1/2	2 1/2	7 1/8	3/8	5/8	2 1/2	1 5/8	4 1/8	2 1/4	2 1/4	1 1/8	12
8	1 1/4	1 1/2	1/2	9 1/2	1 1/8	5/8	7/16	4	3 1/8	2 3/4	12	1 1/4	7/16	—	—	—	—	8	2 5/8	9/16	2 1/4	1 1/8	2	1 1/2	3/4	4	1/2	1/2	—	15/16	4 3/4	2 1/2	7 3/4	1/2	5/8	2 1/2	2	4 1/4	2 1/2	2 1/4	1 5/16	14
8 1/2	1 7/8	1 5/8	1/2	10	1 1/8	5/8	7/16	4 1/2	3 1/2	2 15/16	12	1 1/4	7/16	—	—	—	—	8 1/2	2 3/4	5/8	2 3/8	1 1/8	2	1 5/8	7/8	4	1/2	9/16	3/16	1	5	2 3/4	8 1/4	1/2	5/8	2 3/4	2 1/8	4 3/8	2 1/2	2 1/4	1 5/16	14
9	1 15/16	1 3/4	1/2	10 1/2	1 1/8	11/16	1/2	4 1/2	3 1/2	2 15/16	12	1 3/8	7/16	—	—	—	—	9	2 7/8	11/16	2 3/8	1 1/8	2	1 5/8	7/8	4	1/2	9/16	3/16	1	5 1/8	2 3/4	8 5/8	1/2	5/8	2 3/4	2 1/4	4 1/4	2 1/2	2 1/4	1 5/16	14
9 1/2	2	1 3/4	1/2	11	1 1/4	3/4	1/2	4 5/8	3 5/8	3 1/8	12	1 1/2	1/2	—	—	—	—	9 1/2	3	11/16	2 5/8	1 1/4	2 1/4	1 3/4	7/8	4	1/2	9/16	3/16	1	5 1/2	3	9 1/8	1/2	5/8	3	2 3/8	5 1/8	2 3/4	2 3/4	1 7/16	16
10	2 1/8	1 7/8	1/2	11 1/2	1 1/4	3/4	1/2	4 3/4	3 3/4	3 1/8	12	1 1/2	1/2	—	—	—	—	10	3	5/8	2 5/8	1 1/4	2 1/4	1 3/4	7/8	4	1/2	9/16	5/32	1	5 1/2	3	9 1/2	5/8	3/4	3	2 1/2	5 1/4	2 3/4	2 3/4	1 7/16	16
10 1/2	2 1/4	1 7/8	1/2	12	1 1/4	13/16	1/2	4 7/8	3 7/8	3 1/8	12	1 5/8	1/2	—	—	—	—	10 1/2	3 1/4	3/4	2 3/4	1 3/16	2 1/2	1 7/8	1	4	1/2	5/8	3/16	1 1/16	5 5/8	3 1/4	10	5/8	3/4	3 1/4	2 3/8	5 3/8	2 3/4	2 3/4	1 7/16	16
11	2 1/4	2	1/2	12 1/2	1 1/4	13/16	9/16	4 7/8	3 7/8	3 1/8	12	1 5/8	9/16	—	—	—	—	11	3 3/8	3/4	2 3/4	1 3/16	2 1/2	1 7/8	1	4	1/2	5/8	3/16	1 1/16	5 3/4	3 1/4	10 1/2	5/8	3/4	3 1/4	2 3/8	5 3/4	3	3	1 5/8	18
11 1/2	2 3/8	2	1/2	13	1 3/8	15/16	9/16	5	4	3 1/8	10	1 3/4	9/16	—	—	—	—	11 1/2	3 1/2	13/16	2 7/8	1 1/2	2 3/4	2	1	4	1/2	5/8	3/16	1 1/16	5 7/8	3 3/8	10 3/8	5/8	3/4	3 1/2	3	6 1/8	3 1/4	3 1/4	1 5/8	18
12	2 1/2	2	1/2	13 1/2	1 3/8	7/8	5/8	5	4	3 1/8	10	1 7/8	5/8	—	—	—	—	12	3 5/8	13/16	2 7/8	1 1/2	2 3/4	2	1	4	1/2	5/8	3/16	1 1/16	6	3 3/8	11 3/8	5/8	3/4	3 1/2	3 1/8	6 1/4	3 1/4	3 1/4	1 5/8	18
12 1/2	2 5/8	2	1/2	14 3/8	1 3/8	7/8	5/8	5 1/8	4 1/8	3 1/2	10	1 7/8	11/16	—	—	—	—	12 1/2	3 3/4	13/16	3	1 1/2	2 3/4	2 1/8	1 1/8	4	1/2	5/8	3/16	1 1/16	6 1/16	3 5/8	11 3/4	5/8	3/4	3 3/4	3 1/4	6 3/8	3 1/2	3 1/2	1 7/8	21
13	2 3/4	2 1/8	1/2	14 3/8	1 3/8	7/8	5/8	5 1/4	4 1/4	3 1/2	10	2	3/4	—	—	—	—	13	3 7/8	7/8	3 1/4	1 1/2	2 3/4	2 1/4	1 1/8	4	1/2	3/4	3/16	1 1/8	6 1/8	3 3/8	12 1/4	5/8	3/4	4	3 1/2	6 3/8	3 3/4	3 3/4	1 7/8	21
13 1/2	2 7/8	2 1/8	1/2	15 1/8	1 3/8	7/8	11/16	5 3/8	4 3/8	3 1/2	10	2	3/4	—	—	—	—	13 1/2	4 1/8	7/8	3 3/8	1 1/2	2 3/4	2 3/8	1 1/4	4	1/2	13/16	3/16	1 1/2	6 1/4	3 3/4	12 3/8	5/8	3/4	4 1/4	3 3/4	7 1/4	4	4	1 7/8	21
14	3	2 1/8	1/2	15 3/4	1 1/2	7/8	11/16	5 3/8	4 3/8	3 1/2	10	2 1/8	3/4	—	—	—	—	14	4 1/4	7/8	3 3/8	1 5/8	3	2 3/8	1 1/4	4	1/2	13/16	3/16	1 1/2	6 1/4	3 3/4	13 1/8	5/8	3/4	4 1/4	4	7 1/2	4 1/8	4 1/8	1 7/8	21
14 1/2	3 1/8	2 1/4	1/2	16 1/4	1 1/2	7/8	11/16	5 1/2	4 1/2	3 5/8	10	2 1/8	3/4	—	—	—	—	14 1/2	4 3/8	15/16	3 1/2	1 5/8	3	2 1/2	1 1/4	4	1/2	13/16	3/16	1 1/2	6 3/8	4	13 1/2	5/8	3/4	4 1/2	4	7 3/4	4 1/8	4 1/8	1 7/8	21
15	3 1/8	2 1/4	1/2	16 3/4	1 1/2	7/8	11/16	5 1/2	4 1/2	3 5/8	10	2 1/4	3/4	—	—	—	—	15	4 1/2	15/16	3 1/2	1 5/8	3	2 1/2	1 1/4	4	1/2	13/16	3/16	1 1/2	6 3/8	4	14	5/8	3/4	4 1/2	4	7 3/4	4 1/4	4 1/4	2 1/16	24

LOW PRESSURE VALVES. LIMIT OF WORKING PRESSURE 100 POUNDS.


THIS BRANCH ON CROSS VALVES ONLY.
ALL MATERIAL TO BE OF COMPOSITION EXCEPT WHERE OTHERWISE MARKED. COMPOSITION TO BE OF COPPER 88% TIN 10% ZINC 2%
COMPOSITION NUTS.
ROLLED BRONZE STUDS.
STEEL STUDS COMPOSITION NUTS.
THIS WALL CONICAL ON ALL VALVES.
FALSE SEAT.
NOTE:- VALVES WILL BE CAST WITHOUT FALSE SEAT.
PITCH CIRCLE

SIZE VALVE	A	B	A_1	B_1	C	D	D_1	D_2	D_3	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	R_1	S	T	U	V	W	X	PITCH CIRCLE	NE STUDS OR STUDS IN COVER	NF RIBS IN COVER THICK RIB IN COVER	NF RIBS IN COVER THICK RIB IN VALVE SEAT	a	b	c	d	e	f
1/8	6	1 1/4	3	1	3 3/4		5/8	—				—		1/8									3/8			1/4	—						—	—	—	—					
3/4	7	1 1/2	3 1/2	1 1/8	4 1/8		7/8	—				—		1/8													—						—	—	—	—					
1	7 1/2	1 5/8	3 3/4	1 3/8	4 3/8	2 3/4	1 1/8	—			1/16	—		1/8		1 1/4							3 3/8			1/4	—						—	—	—	—					
1 1/4	8 1/2	2 1/8	4 1/4	1 1/2	5 1/4	3	1 3/8	—			1/16	—		1/8		1 1/4							4			1/4	—						—	—	—	—					
1 1/2	8 3/4	2 1/2	4 3/8	1 5/8	5 1/8	3 1/2	1 3/4	—			1/16	—		1/8		1 1/2							4 3/8			1/4	—						—	—	—	—					
2	10 1/4	2 7/8	5 1/8	1 7/8	6 3/4	4	2 1/4	—	2 3/4	3/4	1/16	—	4 1/2	1/8	3/4	1 1/2	1 1/4	2 3/8	9/16	1/16	1 1/8	4	6	1/2	1 1/8	5/16	—	5/8	3	5/8	5 3/8	6	5/8	—	—	—	—	7/16	7/16	1/2	1 7/16	2 1/2	1 7/16
2 1/2	11 1/2	3 3/8	5 3/4	2 1/4	7 1/4	4 3/4	2 1/2	—	3 3/4	7/8	1/16	—	5 1/8	1/8	3/4	1 3/4	1 3/8	2 3/8	5/8	1/16	1 1/4	4 3/8	6 3/4	1/2	1 1/8	3/8	—	5/8	3 3/4	5/8	6	8	5/8	—	—	—	—	1	1/2	9/16	1/2	2 3/8	2
3	12 1/2	3 3/4	6 1/4	2 1/2	8 1/8	5 1/2	3	1/4	—	1	7/8	1/16	—	5 3/4	7/16	1/8	1 1/2	2 5/8	5/8	1/16	1 3/4	5 1/8	7 3/4	1/2	1 3/8	3/8	—	3/4	3 3/4	3/4	6 3/4	8	3/4	4	3/8	—	—	1 1/8	1/2	9/16	1/2	2 3/8	2 1/8
3 1/2	13	4 1/4	6 1/2	2 3/8	8 3/8	6	3 3/4	—	4 1/2	1	1/8	—	6 1/4	7/16	7/8	2	1 5/8	2 3/4	3/4	1/16	2	5 3/8	8 1/8	1/2	1 3/8	7/16	—	3/4	3 7/8	3/4	7 1/4	8	3/4	4	3/8	—	—	1 1/8	5/8	3/4	5/8	3	2 1/8
4	13 3/4	4 3/4	6 3/4	2 5/8	9 1/2	7	4 1/2	—	5 1/2	1	1/8	—	6 3/4	7/16	1	2 1/8	1 3/4	2 7/8	7/8	1/16	2	6 1/4	9 1/8	1/2	1 3/8	7/16	—	7/8	4 1/4	3/4	7 3/4	10	3/4	4	3/8	3	1/4	1 1/8	5/8	3/4	5/8	3 1/2	2 1/2
4 1/2	15	5 1/4	7 1/8	3	10 1/8	8	5	3/4	6	1 1/8	1/8	1/16	7 1/2	1/2	1 1/8	2 3/8	1 7/8	3 1/4	1	1/16	2 1/4	7 1/4	10 1/4	1	1 7/8	1/2	1 3/8	1	4 5/8	3/4	8 5/8	10	3/4	4	3/8	3	1/4	1 1/4	5/8	3/4	5/8	3 5/8	2 3/4
5	16	5 3/4	8	3 1/8	11 1/8	8 3/4	5 1/2	6 1/4	6 3/8	1 1/8	1/8	1/16	8 1/4	5/8	1 1/8	2 3/8	2	3 3/4	1 1/8	1/16	2 1/4	7 3/8	11 3/8	1	2 1/8	1/2	1 3/8	1 1/8	5 1/4	7/8	9 3/8	10	7/8	4	3/8	3	3/8	1 1/4	5/8	3/4	5/8	3 3/4	2 3/4
5 1/2	16 3/4	6 1/4	8 3/8	4 1/8	12	9 1/2	6	7/8	7	1 1/4	1/8	1/16	8 7/8	5/8	1 1/8	2 1/2	2 1/4	3 3/8	1 1/4	1/16	2 3/8	8	12 1/4	1	2 1/8	1/2	1 1/2	1 1/8	5 1/4	7/8	10	10	7/8	4	3/8	3	3/8	1 1/4	5/8	3/4	5/8	3 7/8	2 3/4
6	18	6 3/4	9	4 1/2	12 1/2	10 1/4	6 1/2	7/8	7 1/2	1 1/4	1/8	1	9 3/8	5/8	1 1/8	2 3/8	2 1/4	3 3/4	1 1/4	1/16	2 3/8	8 1/2	13 1/4	1/2	2 3/8	5/8	1 1/2	1 1/8	5 1/2	1	10 1/2	10	7/8	4	1/2	3	3/8	1 3/8	3/4	7/8	3/4	4 1/2	3
6 1/2	18 3/4	7 3/8	9 3/8	4 3/8	13 1/4	11	7	1/8	8	1 1/4	1/8	1 1/16	10	5/8	1 1/8	2 3/8	2 1/4	3 7/8	1 3/8	1/16	2 3/4	9 1/4	14	1/2	2 3/8	5/8	1 3/4	1 1/4	5 5/8	1 1/8	11 1/2	12	7/8	4	1/2	3	1/2	1 3/8	3/4	7/8	3/4	4 1/8	3 1/4
7	20	8	9 3/8	5	14	11 1/8	7 3/4	8 3/8	9	1 1/2	1/8	1 1/8	10 3/8	5/8	1 1/8	3	2 1/2	4	1 3/8	1/16	2 3/8	10	15 1/2	1/2	2 5/8	5/8	1 3/4	1 3/8	6 1/4	1 1/8	12	12	7/8	4	1/2	3	1/2	1 3/8	3/4	7/8	3/4	4 1/2	3 3/8
7 1/2	21 1/2	8 3/8	10	5 1/4	14 1/2	12 3/8	8 1/4	9 3/8	9 1/4	1 1/2	1/8	1 1/4	11 1/8	5/8	1 1/4	3 1/2	2 3/4	4 3/8	2	1/16	3 3/8	10 3/8	16 3/8	1/2	2 3/8	11/16	1 1/2	1 1/2	6 1/4	1	12 3/8	12	1	4	1/2	3	1/2	1 3/8	3/4	7/8	3/4	4 5/8	3 5/8
8	22 3/4	9 3/8	10 3/8	5 1/2	15 1/4	13 1/2	9	9 7/8	10	1 5/8	1/8	1 1/16	11 7/8	5/8	1 1/4	3 3/8	3	4 1/2	2	1/8	3 1/4	10 3/4	17 3/8	1/2	2 3/8	11/16	1 3/8	1 1/2	7 1/8	1	13 3/8	12	1	4	5/8	3	5/8	1 1/2	7/8	1	7/8	5 1/8	3 3/8
8 1/2	24	9 3/8	10 3/4	5 3/4	16	14 1/4	9 1/2	10 1/2	10 3/4	1 3/4	1/8	1 1/16	12 1/2	5/8	1 1/4	3 3/8	3	4 3/8	2	1/8	3 3/8	11 1/8	18 3/4	1/2	3 1/8	3/4	2 3/8	1 3/8	7 3/8	1	13 3/8	14	1	4	5/8	3	5/8	1 1/2	7/8	1	7/8	5 1/4	3 5/8
9	25 1/2	10 1/8	11 1/4	6	16 3/8	15	10	11	11 1/8	1 7/8	1/8	1 1/8	13	5/8	1 1/4	3 3/8	3	4 3/8	15/16	1/8	3 1/2	12	20	1/2	3 1/4	3/4	2 5/8	1 3/8	7 3/8	1	14 1/8	14	1	4	5/8	3	5/8	1 1/2	7/8	1	7/8	5 3/8	4
9 1/2	26 1/4	10 3/8	11 3/8	6 1/4	17 3/8	15 3/8	10 1/8	11 1/8	11 3/4	1 7/8	1/8	1 1/8	13 5/8	5/8	1 1/4	3 3/8	3 1/4	5 1/8	15/16	1/8	3 1/2	12 3/4	21	1/2	3 1/4	3/4	2 5/8	1 3/8	8 1/4	1 1/8	15	14	1 1/8	4	5/8	3	5/8	1 1/2	7/8	1	7/8	5 3/4	4 1/4
10	28	11 1/4	12	6 1/2	18	16 3/8	11	12	12 1/4	2	1/8	1 1/8	14 3/8	5/8	1 3/8	3 3/8	3 3/4	5 3/8	1	1/8	3 3/8	12 3/8	22		3 1/2	1/16	2 5/8	1 3/8	9	1 1/8	15 1/2	14	1 1/8	4	5/8	3	3/4	1 1/8	7/8	1	7/8	5 3/4	4 1/4
10 1/2	29 1/2	11 3/4	12 3/8	6 3/4	18 3/4	17 1/4	11 1/2	12 3/8	12 3/4	2 1/8	1/8	1 1/8	14 7/8	5/8	1 3/8	4	3 1/2	5 3/8	1	1/8	3 3/8	13 1/2	23		3 3/4	1/16	2 5/8	2	9	1 1/8	16 1/2	16	1 1/8	4	3/4	3	3/4	1 1/8	1	1 1/8	1	5 7/8	4 3/8
11	30 1/2	12 1/8	13	7	19 1/8	18	12	13	13 1/4	2	1/8	1 1/8	15 1/2	5/8	1 3/8	4 1/8	3 1/2	5 1/2	1 1/8	1/8	4	14 1/8	24		3 3/4	1/16	2 5/8	2	9 1/4	1 1/8	17	16	1 1/8	4	3/4	3	3/4	1 1/8	1	1 1/8	1	6	4 1/2
11 1/2	31 1/4	12 3/8	13 1/4	7 1/4	20	18 3/8	12 3/8	13 3/8	13 3/4	2 1/8	1/8	1 1/8	16	5/8	1 3/8	4 3/8	3 3/4	5 3/4	1 1/8	1/8	4 1/4	14 3/8	25		4 1/4	1/16	2 5/8	2 1/4	10	1 1/8	17 1/2	16	1 1/8	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 1/4	4 3/4
12	33	13	13 3/8	7 1/2	20 3/8	19	13	14	14 3/8	2 1/8	1/8	1 1/8	16 3/8	5/8	1 3/8	4 3/4	4	6	1 1/8	1/8	4 3/8	15 3/8	26		4 1/4	1/16	2 5/8	2 1/4	10	1 1/8	18 3/8	16	1 1/8	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 3/8	4 7/8
12 1/2	34	13 3/8	14 1/8	7 3/4	21 1/8	20 1/4	13 3/8	14 1/4	14 3/8	2 1/8	1/4	1 1/8	17	5/8	1 1/8	4 3/8	3 3/4	6 3/8	1 1/8	1/8	4 1/2	15 3/4	28		4 1/4	1	2 5/8	2 1/4	10 1/2	1 1/8	18 3/8	18	1 1/4	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 5/8	5
13	36	13 3/4	14 3/8	8	22 1/8	21	14	15 1/4	15 3/8	2 1/4	1/4	1 1/8	17 3/8	5/8	1 1/8	4 5/8	4	6 1/4	1 1/8	1/8	4 3/8	16 1/8	28		4 1/4	1	2 5/8	2 1/4	11	1 1/4	19 1/8	18	1 1/4	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 5/8	5
13 1/2	37 1/2	14 1/8	15 1/4	8 1/4	23	21 3/8	14 3/8	15 1/4	15 3/8	2 1/4	1/4	1 1/8	18 1/8	5/8	1 1/8	4 3/4	4	6 3/8	1 1/8	1/8	4 3/8	17 1/4	29		4 1/4	1 1/16	2 5/8	2 1/4	11 1/4	1 1/4	20 1/4	18	1 1/4	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 3/4	5 1/8
14	39	14 1/8	15 3/4	8 3/8	23 3/4	22 1/4	15 1/4	16 1/8	16 3/8	2 1/4	1/4	1 1/8	19 1/8	5/8	1 1/8	5	4	6 3/8	1 1/8	1/8	4 3/8	17 1/8	31		4 1/4	1 1/16	2 3/4	2 1/4	11 1/4	1 1/8	21	18	1 1/4	4	3/4	4	3/4	1 1/4	1	1 1/8	1	6 7/8	5 1/8
14 1/2	40 1/2	15	16 1/4	8 3/4	24 1/4	23 1/4	15 3/4	16 7/8	17 1/8	2 1/4	1/4	1 1/8	19 7/8	5/8	1 1/8	5 1/4	4 1/4	6 7/8	1 1/8	1/8	5 1/8	18 1/8	32		5	1/16	2 3/4	2 3/4	12 1/4	1 1/8	21 1/8	18	1 1/4	4	3/4	4	3/4	1 1/4	1	1 1/8	1	7 1/8	5 1/4
15	42	15 1/8	16 3/8	9 1/4	24 3/8	24	16 1/4	17 3/8	17 1/8	2 1/4	1/4	1 1/8	20 1/8	5/8	1 1/8	5 1/4	4 1/4	7	1 1/4	1/8	5 1/4	19	33		5	1/16	2 3/4	2 3/4	13	1 1/8	22	18	1 1/4	4	3/4	4	3/4	2	1	1 1/8	1	7 1/4	5 3/4

HEAVY PRESSURE VALVES. LIMIT OF WORKING PRESSURE 300 POUNDS.



SIZE VALVE.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	a	b	c	d	No. THDS ON SPINDLE	e	f	g	h	h_1	i	k	l	m	n	o.	r	S
1/8	1/4			13/16							—	—						—						1/2		3		—		8											7/16	—	
2/4	1/4			1 1/16							—	—						—						5/8		4		—		7											1/2	—	
1	1/4	1/2	1/4	1 3/8	—	—	—	1 1/2	1 3/8	1 1/16	16	—	—	5/8	1/8	3/16	1/8	—	7/8	11/16	1/8	1 1/16	3/8	7/8	3/4	3/8	5	5/16	—		6											5/8	—	
1 1/4	5/16	1/2	1/4	1 7/8	—	—	—	1 3/4	1 1/2	1 1/4	16	—	—	3/4	1/8	3/16	1/8	—	7/8	3/4	3/16	1 1/16	3/8	7/8	3/4	3/8	6	5/16	—		6											11/16	—	
1 1/2	5/16	1/2	1/4	2	—	—	—	1 3/4	1 1/2	1 1/4	16	—	—	3/4	1/8	3/16	1/8	—	1	15/16	1/4	1 3/16	3/8	1	7/8	1/2	6	3/8	—		6											11/16	—	
2	5/8	9/16	1/4	2 1/2	—	—	—	2 1/8	1 3/4	1 7/16	14	—	—	1	5/16	1/4	5/16	—	1 1/4	1 5/16	5/16	1 1/4	3/8	1 1/4	7/8	1/2	7	3/8	—	9/16	6	3/4	3/8	2 1/8	1 1/8	3/4	1/4	7/8	3	1 1/2	5/8	3/4	—	1 1/16	
2 1/2	7/16	5/8	5/16	3 1/8	—	—	—	2 5/8	2	1 5/8	14	—	—	1 1/8	5/16	1/4	3/16	—	1 3/8	1 1/16	3/8	1 5/16	3/8	1 1/8	1	1/2	7	3/8	—	9/16	5	3/4	3/8	2 1/16	1 1/8	3/4	1/4	7/8	3 1/8	1 5/8	5/8	3/4	—	1 1/16	
3	1/2	3/4	5/16	3 3/4	—	—	—	2 5/8	2 1/4	1 13/16	12	—	—	1 1/8	3/8	1/4	3/16	—	1 3/8	1 1/4	3/8	1 5/8	3/8	1 1/8	1 1/8	5/8	8	1/2	—	1/16	5	1 1/16	1/2	2 1/16	1 1/8	7/8	5/16	1 1/16	3 3/4	2 1/8	3/4	7/8	—	1 1/16	
3 1/2	9/16	1 3/16	3/8	4 1/8	—	—	—	2 5/8	2 1/2	2	12	—	—	1 1/2	1/4	1/4	3/16	—	1 1/2	1 3/8	7/16	1 7/8	5/8	1 1/2	1 1/4	5/8	9	1/2	—	1/16	4	1 1/16	1/2	2 1/16	1 1/8	7/8	5/16	1 1/16	3 7/8	2 1/4	3/4	15/16	—	1 1/16	
4	1 1/8	7/16	3/8	4 3/4	1/2	1/2	7/16	3 1/8	2 5/8	2	12	—	—	—	—	—	—	4	1 5/8	1 1/2	7/16	2	3/4	1 5/8	1 3/8	3/4	10	1/2	—	1 1/16	4	1 1/8	9/16	3 1/4	1 1/8	1	5/16	1 1/4	4 1/4	2 3/8	7/8	1	—	1 5/16	
4 1/2	1 1/4	7/16	3/8	5 3/8	3/4	5/8	7/16	3 3/4	2 7/8	2 3/8	12	—	—	—	—	—	—	4 1/2	1 5/8	1 5/8	1/2	2 1/4	3/4	1 3/4	1 1/2	3/4	10	1/2	—	1 1/16	4	1 1/4	5/8	3 5/8	1 1/8	1	3/8	1 7/16	4 3/4	2 5/8	1	1	—	1	
5	1 3/8	1 1/16	3/8	5 5/8	7/8	6/8	7/16	3 3/4	3 1/8	2 3/8	12	—	—	—	—	—	—	5	1 3/4	1 13/16	1/2	2 1/4	7/8	1 3/4	1 1/2	3/4	11	1/2	—	1 1/16	4	1 3/8	5/8	3 3/4	1 1/4	3/8	3/8	1 5/8	5 1/4	2 5/8	1 1/8	1 1/16	—	1 1/4	
5 1/2	1 1/2	1 1/8	3/8	6 3/8	7/8	1 1/16	4	3 3/4	2 3/4	2 3/8	12	—	—	—	—	—	—	5 1/2	1 3/4	1 7/8	9/16	2 5/8	7/8	1 7/8	1 5/8	7/8	12	9/16	5/8	1	4	1 3/8	5/8	3 11/16	1 2/8	1 1/4	3/8	1 5/8	5 1/4	2 3/4	1 1/8	1 1/16	—	1 1/4	
6	1 5/8	1 1/8	3/8	6 7/8	7/8	1 1/16	1/2	4 1/4	3 1/2	2 3/4	12	1 1/2	3/8	—	—	—	—	6	1 3/4	2	5/8	2 5/8	7/8	2	1 3/4	7/8	12	9/16	5/8	1	4	1 3/8	3/4	4 3/4	2 1/8	1 3/8	3/8	1 3/4	5 1/2	3	1 1/4	1 1/8	—	1 1/4	
6 1/2	1 5/8	1 1/4	3/8	7 1/2	1	1 1/8	1/2	4 1/2	3 3/4	2 13/16	12	1 1/2	3/8	—	—	—	—	6 1/2	1 3/4	2 1/16	5/8	2 3/4	1	2 1/8	1 7/8	1	14	5/8	3/8	1 1/8	4	1 3/8	3/4	4 5/16	2 1/8	1 3/8	3/8	1 3/4	5 5/8	3 1/8	1 1/4	1 5/16	—	1 1/4	
7	1 3/4	1 3/8	1/2	8 1/4	1	1 1/8	9/16	4 3/4	4	3 1/8	12	1 1/8	3/8	—	—	—	—	7	1 3/4	2 1/16	11/16	2 7/8	1	2 1/4	2	1	14	5/8	3/8	1 1/4	4	1 3/8	7/8	4 3/4	2 1/8	1 3/8	3/8	1 3/4	6 1/4	3 1/2	1 3/8	1 1/8	—	1 1/8	
7 1/2	1 7/8	1 1/2	1/2	8 3/4	1	1 1/16	9/16	4 7/8	4 1/8	3 1/8	10	1 1/8	7/16	—	—	—	—	7 1/2	1 3/4	2 1/4	3/4	3 1/8	1	2 3/8	2 1/8	1 1/8	14	3/4	7/16	1 1/8	4	1 5/16	1	4 3/8	2 1/4	1 5/8	7/16	1 7/8	6 3/4	3 5/8	1 1/2	1 5/16	—	1 7/16	
8	2	1 1/2	1/2	9 1/2	1 1/8	1 3/16	5/8	5 1/8	4 1/4	3 1/2	10	1 1/8	7/16	—	—	—	—	8	2	2 5/8	1 1/16	3 1/4	1 1/8	2 1/2	2 1/4	1 1/8	16	3/4	7/16	1 1/8	4	1 5/16	1	5	3 1/2	1 5/8	7/16	2 1/16	7 1/8	4	1 1/2	1 7/16	—	1 7/16	
8 1/2	2 1/8	1 5/8	1/2	10	1 1/8	1 3/16	5/8	5 1/2	4 1/2	3 1/2	10	1 1/8	7/16	—	—	—	—	8 1/2	2	2 3/4	1 1/16	3 3/8	1 1/8	2 5/8	2 3/8	1 1/4	16	13/16	7/16	1 1/2	4	1 5/16	1 1/16	5 1/8	3 1/4	1 5/8	7/16	2 1/8	7 1/4	4 1/8	1 5/8	1 7/16	—	1 1/2	
9	2 1/4	1 3/4	1/2	10 1/2	1 1/8	1 3/16	11/16	5 3/4	4 3/4	3 7/8	10	1 1/8	7/16	—	—	—	—	9	2	2 7/8	1 1/16	3 1/2	1 1/8	2 3/4	2 1/2	1 1/4	16	13/16	7/16	1 1/2	4	2 1/16	1 1/16	5 3/8	3 1/4	1 5/8	1/2	2 1/8	7 3/4	4 1/4	1 5/8	1 7/16	—	1 11/16	
9 1/2	2 1/4	1 3/4	1/2	11	1 1/4	1 5/16	11/16	5 7/8	4 7/8	3 7/8	10	1 1/8	7/16	—	—	—	—	9 1/2	2 1/4	3	1 5/16	3 5/8	1 1/4	2 7/8	2 5/8	1 1/4	18	7/8	7/32	1 3/4	4	2 1/16	1 1/16	5 5/8	4	1 5/8	1/2	2 3/16	8 1/4	4 3/8	1 3/4	1 5/8	—	1 11/16	
10	2 3/8	1 7/8	1/2	11 1/2	1 1/4	1	3/4	6 1/8	5 1/8	4 1/4	10	2	1/2	—	—	—	—	10	2 3/8	3	1	3 5/8	1 1/4	3	2 5/8	1 1/2	18	7/8	7/32	1 3/4	4	2 1/4	1 1/16	5 3/4	4	2	1/2	2 3/4	9	4 3/8	1 7/8	1 5/8	2 1/4	1 7/8	
10 1/2	2 3/8	1 7/8	1/2	12	1 1/4	1 1/16	3/4	6 3/8	5 1/4	4 1/4	10	2	1/2	—	—	—	—	10 1/2	2 3/8	3 3/4	1	4	1 3/8	3	2 3/4	1 1/2	18	7/8	7/32	1 3/4	4	2 1/8	1 1/8	6	4 1/4	2 1/4	5/8	2 5/16	9	5	2	1 5/8	2 1/8	1 15/16	
11	2 5/8	2	1/2	12 1/2	1 1/4	1 1/16	13/16	6 1/2	5 1/2	4 1/2	10	2 1/8	9/16	—	—	—	—	11	2 1/2	3 3/8	1 1/16	4 1/8	1 3/8	3 1/8	2 7/8	1 5/8	21	15/16	7/32	1 7/8	4	2 1/8	1 3/16	6 1/4	4 1/2	2 1/4	5/8	2 5/16	9 1/4	5 1/8	2	1 5/8	2 1/8	1 15/16	
11 1/2	2 5/8	2	1/2	13	1 3/8	1 1/8	13/16	6 7/8	5 3/4	4 5/8	10	2 1/8	9/16	—	—	—	—	11 1/2	2 3/4	3 1/2	1 1/16	4 3/8	1 1/2	3 1/4	3	1 1/4	21	1	7/32	2	4	2 1/16	1 3/16	6 1/2	4 5/8	2 1/2	3/4	3 3/8	10	5 1/2	2 1/4	1 7/8	2 1/8	2 1/8	
12	2 3/4	2	1/2	13 3/8	1 3/8	1 1/8	7/8	7	5 7/8	5	10	2 1/4	5/8	—	—	—	—	12	2 3/4	3 5/8	1 1/16	4 1/2	1 1/2	3 3/8	3 1/8	1 1/4	21	1	7/32	2	4	2 1/16	1 3/16	6 3/4	4 3/4	2 1/2	3/4	3 3/8	10	5 3/8	2 1/4	1 7/8	2 1/8	2 1/8	
12 1/2	2 7/8	2	1/2	14 3/8	1 3/8	1 1/4	7/8	7 1/4	6	5	10	2 1/4	11/16	—	—	—	—	12 1/2	2 3/4	3 3/4	1 1/8	4 5/8	1 1/2	3 3/8	3 1/4	1 1/4	21	1	7/32	2	4	2 1/16	1 3/16	6 3/4	4 7/8	2 3/4	3/4	3 3/8	10 1/2	6	2 1/4	1 7/8	2 1/8	2 1/8	
13	3	2 1/8	1/2	14 3/8	1 3/8	1 1/4	15/16	7 1/2	6 1/4	5	10	2 3/8	3/4	—	—	—	—	13	2 3/4	4	1 1/8	4 5/8	1 1/2	3 1/2	3 1/4	1 1/4	21	1	7/32	2	4	3 1/8	1 1/4	7 1/8	5	2 3/4	7/8	3 1/2	11	6	2 1/2	1 7/8	3	2 1/8	
13 1/2	3 1/8	2 1/8	1/2	15 3/8	1 3/8	1 1/4	15/16	7 3/4	6 1/2	5 3/8	10	2 3/8	3/4	—	—	—	—	13 1/2	2 3/4	4 1/8	1 1/8	4 3/4	1 1/2	3 5/8	3 3/8	2	24	1 1/4	7/32	2 1/4	4	3 1/8	1 1/4	7 1/4	5 1/8	2 3/4	7/8	3 1/2	11 1/4	6 1/8	2 1/2	2 1/16	3	2 1/8	
14	3 1/8	2 1/8	5/8	16	1 1/2	1 3/8	1 5/16	8	6 1/8	5 1/8	10	2 3/8	3/4	—	—	—	—	14	3	4 1/4	1 3/16	4 7/8	1 5/8	3 3/4	3 1/2	2	24	1 1/4	7/32	2 1/4	4	3 1/8	1 1/4	7 1/2	5 1/4	2 3/4	7/8	3 1/2	11 1/2	6 1/2	2 1/2	2 1/16	3	2 1/8	
14 1/2	3 1/4	2 1/4	5/8	16 1/2	1 1/2	1 3/8	1	8 1/4	6 1/4	5 1/4	10	2 1/2	3/4	—	—	—	—	14 1/2	3	4 3/8	1 3/16	5	1 5/8	3 5/8	3 3/8	2	24	1 1/4	7/32	2 1/4	4	3 1/4	1 1/4	7 3/4	5 3/8	3	1	3 7/8	12 1/4	6 7/8	2 3/4	2 1/16	3 1/4	2 1/8	
15	3 3/8	2 1/4	5/8	17	1 1/2	1 3/8	1	8 1/2	7	5 3/4	10	2 1/2	3/4	—	—	—	—	15	3	4 1/2	1 1/4	5 1/4	1 5/8	3 7/8	3 1/4	2	24	1 1/4	7/32	2 1/4	4	3 1/4	1	2	8	5 3/4	1	3	13	7 1/4	2 3/8	2 1/16	3 1/4	2 1/8	

HEAVY PRESSURE VALVES. LIMIT OF WORKING PRESSURE 300 POUNDS.

The Fremont Method of Determining the Fragility of Iron and Steel.*

BY THORSTEN Y. OLSEN.

In this paper I will endeavor to explain the Fremont method of testing iron and steel. My knowledge of the subject is based mostly on translations which I have made, from the French, of Mr. Fremont's many papers to the Society for the Encouragement of the National Industry, together with a personal acquaintance with Mr. Fremont at Paris in 1900. In addition, I have been able to make various experiments on one of the Fremont machines at the laboratory of Tinius Olsen & Co.

To fully explain this method and machine it is necessary to give the reasons for the desire for a new method, the comparison with other methods, and results obtained by this new method unobtainable in any other manner.

For several centuries past, methods of testing have undergone considerable changes; thus in the seventeenth and eighteenth centuries the test by a blow was considered as the foremost and hardest test for a steel to undergo. No exact means, however, was known at that time for determining the force of the blow, and hence the test was in a crude and uncontrollable form. The test by tension was also used at this time, but only became known as the principal form of testing after the middle of the nineteenth century. Thus, according to Mr. Fremont, the test of tension owes its growth to research work on iron and steel by Mr. David Kirkaldy, in 1860, together with the development of the bessemer steels. From this time the test of tension increased in importance, while that of shock or impact, as a factor, lessened.

With tension testing definite results may be obtained; in fact, the standard machines of to-day are by far more accurate than the homogeneity of the metal warrants. Today all the formulas on which engineering problems are based are derived from results obtained from tension testing. Standards have consequently been adopted for various materials, varying with the known stresses they may be subjected to.

Due to the lack of homogeneity of a steel and to the unknown stresses which must frequently take place, factors of safety are stipulated; thus, if a boiler, rail, or other structure is designed properly, it should break only by an unknown fault in the material. Accidents occur; but should they be called accidents when possibly they might be avoided? The defects in the steel are either lack of homogeneity or excessive fragility or both. While the manufacturer has been plodding on, testing his material as required, being then safe from further responsibility or criticism, the scientist has been endeavoring to obviate, to the best of his knowledge, these two faults of steel. The first fault, that of lack of homogeneity, may be eliminated only slightly by making a greater number of tests; the second, by an impact or shock test. To-day there is an impact test prescribed for a rail; why not for a boiler plate, wheel-tire, or any portion of a mechanism subjected at some time or other to an abrupt or intermittent stress?

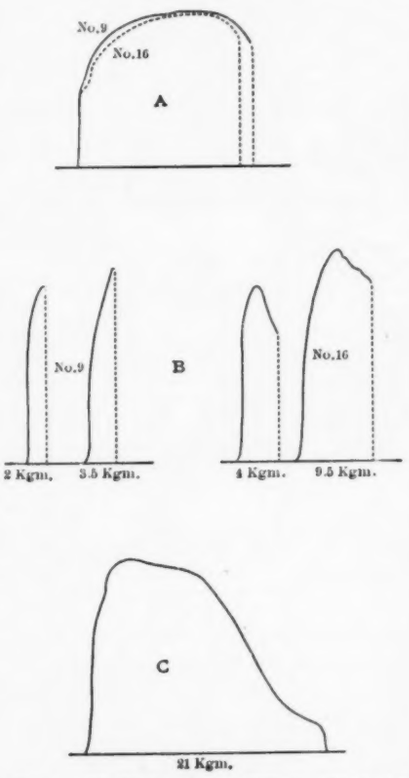


FIG. 1. TENSILE AND BENDING TESTS OF THE SAME STEELS.

The "fragility" is a known factor as far as the knowledge of its existence, but no further. Through lack of method, machine and standards, the consumer, together with the producer, have alike been compelled to ignore the fragility of their steel. Mr. Fremont, intent on releiving this state of affairs, and being in a position to fully investigate various methods of testing, commenced a series of investigations to determine the best means of testing for the fragility of steel.

In France, testing as done in this country is looked upon as an extravagance, and only the largest companies can afford a moderate size testing machine. The cost of the material and preparation of tension-test pieces are also considered a great expense, and hence Mr. Fremont, considering this, together with the desire of testing portions of plates nearest to the portion actually used, and of testing thin plates, made his test specimen very small throughout his various experiments; thus, his specimens are 10 mm. wide by 8 mm. thick and 30 mm. long, with a notch cut crosswise in the center of one of its broad sides, 1 mm. wide by 1 mm. deep.

Mr. Fremont first experimented with the bending test, and bent his small specimens over a die 20 mm. long, with a punch-shaped tool.

Now take two steels which have given approximately the same diagram by the tension test; call these two steels No. 9 and No. 16, as in *A* Fig. 1. Subject this same material to a bending test. The second set of curves, at *B*, were obtained from these two steels tested both with the rolling and at right angles to it. These curves show that in both cases No. 16 broke with a greater amount of work than No. 9, although the reverse was shown by the test of tension. Then, again, at *C* is a bending diagram of a steel which gave a similar tension diagram. This, as can readily be seen, gives a far better bending test than either of the other two steels.

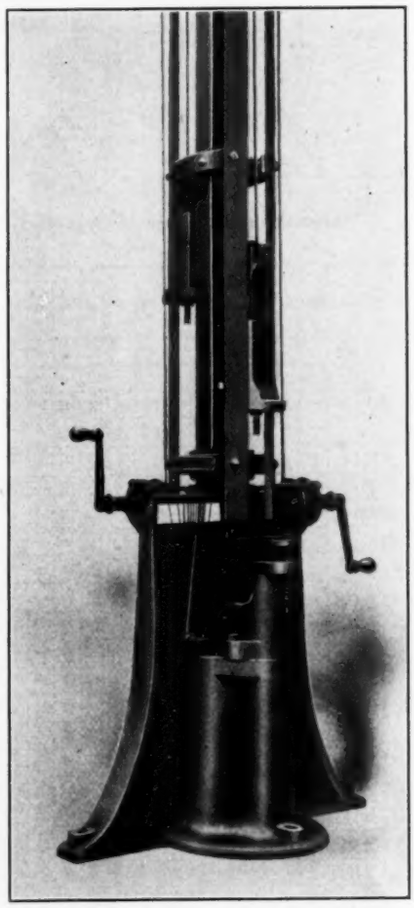


FIG. 2. THE FREMONT TESTING MACHINE.

These bending tests reveal some quality of the steel not revealed by the tension tests. Does the bending test reveal all? Will it reveal this quality on a less ductile steel?

It has been proposed to require all steel to stand a certain drop of a hammer, and keep this a standard. Then, however, two points for discussion would arise:

*Extracts from a paper read before the Engineers' Club of Philadelphia.

First, the possibility of an arbitrary appreciation of the commencement of rupture.

Second, the total resistance of the metal could not be measured.

Let us take a slightly different form of drop testing. Take a bar and mark it off by small notches and place it under a hammer, dropping the same through successive hights, until a point is reached where an increase or decrease will rupture or prevent rupture of the bar.

In comparing tests effected by rupturing specimens by a repetition of blows and by a single blow, Mr. Fremont found that some steels ruptured by a single blow required but one-third to one-fourth the amount of work required by the repeated blows, and thus impact testing employing a repetition of blows is little better than a bending test. Steels appearing non-fragile by the first method would appear fragile when subjected to a single drop of a hammer just sufficient to break the bar.

Knowing the desirability for an accurate and easy means for shock testing, Mr. Fremont presented a communication to the Academy of Science in 1897 proposing a method of registering the amount of work required to produce rupture by this means.

As the speed of impact is a great factor, it is necessary to make the speed of the hammer sufficiently great to rupture the specimen with one blow, whatever the quality of the metal. If a steel then proves non-fragile to a drop of this kind, it has been proven non-fragile to the test of a cannon. To determine the amount of work absorbed to produce this rupture, it is necessary to measure the residual work that is possessed by the hammer after rupture of the specimen. After numerous tests by shock, Mr. Fremont finished a machine embodying principles by which this residual force could be measured. First, "crushers" were employed from which the residual force in the hammer could be measured from their known compression; this, however, was not very practical, and so in the commercial machine a set of springs is used to measure this residual force.

The machine as built to-day is shown in Fig. 2 which represents the lower portion of the machine. The design is made double; *i. e.*, it is arranged so that two may operate on the same machine at the same time. The base of the machine is composed of two parts connected by bolts. Between them, and held tightly by them, is a central I-beam. This carries six gray-iron supports, at intervals, to which are bolted the four rolled steel guides. Two anvils are bolted on opposite sides of the base, the whole weighing more than 1500 lbs. The weights of the hammers are 20 and 30 lbs., or about 1/70 the total weight of the machine. The anvils contain in front and in back of the matrix vertical cylindrical holes serving for the lodgement of two springs. A cap of hard steel is placed directly over them. It is this cap or platform which receives the hammer after the rupture of the specimen.

Tension Test.		Shock Test.		
Tensile Strength. Kilog.	Elongation in 20 Cm. Percentage.	Average Work. Kgm.	Maximum Work. Kgm.	Minimum Work. Kgm.
39	30	28.80	32	23.50
42	28	25	30	22.50
43	30	27.30	30	24.50
45	22	25.40	29	22.50
46	28	25.40	30.50	26
49	27	21.50	24	19.50
50	25	22.35	25	20
Specimens Tested With the Rolling.				
Tension Test.		**Shock Test.**		
Tensile Strength. Kilog.	Elongation in 20 Cm. Percentage.	Average Work. Kgm.	Maximum Work. Kgm.	Minimum Work. Kgm.
37	25	21.43	23.50	19
38	25	20.50	24	18
40	25	21.7	23	19.50
Specimens Tested Across the Rolling.				

TABLE 2. COMPARISON OF TENSILE AND SHOCK BENDING TESTS.

Tension Test.		Static Bending.		Bending by Shock.			
				Notched by a Saw.		Notched by a Milling Cutter.	
Tensile Strength. Kilog.	Elongation in 20 Cm. Percentage.	Lengthwise. Kgm.	Crosswise. Kgm.	Lengthwise. Kgm.	Crosswise. Kgm.	Lengthwise. Kgm.	Crosswise. Kgm.
47	24	9.5	8	13	6	10	6.5
60	25	4.5	2.5	4.5	4	6	6
44	28	12.5	10	6	6	6.5	4.5
37	30	22	20	9	7	1	7.5
33	25	12.5	2	9	3	3	2
33	32	21	20	5.5	3	4	3.5
45	27	5.5	6	3	4	5.5	4.75
60	22	15.5	4	7	3.5	6.75	3
50	20	5.5	12	7	5	6	4
40	23	22.5	17.5	22	13	21	19
53	23	4	3	5	2.5	5.2	3
49	27	20.5	6	22 19.5 21.5 21.5	5	24 21.5 21.5 24	4
46	27	25	12	30.5 29 29 26	17.5 18.5	26.5 26 30	16 17.5 17
43	28	22	19	24.5 25 25.5 30	22.5 19 21.5	22.5 23 24	19.5 23 23.5
50	26	24.5	6.5	20 22 22.5 23	5 5	22.5 22.5 21.5	4.5

TABLE 1. COMPARISON OF TENSILE, STATIC BENDING AND SHOCK BENDING TESTS.

The hammer compresses the springs and the space traversed by them is then measured. As the springs rebound after the blow, it violently repels the cap, and so to offset this new shock the cap is held by two small springs, one of which is visible on the front of the anvil. These springs thus serve merely as a deadener to the cap when rebounding.

On each side of the base and to the right of the operator is a windlass, by which the hammer is easily and quickly raised. A ratchet and lever prevent the downward motion of the hammer when placing the specimen in position. Each hammer has inserted at its lower extremity a hardened steel punching tool. A gripping device holds the hammer to the pulling cord until automatically released at the top of the machine.

To operate the machine we first raise the weight enough to allow room to place the specimen in position, notch side down, with notch directly in the center of the die. Then we turn the windlass, raising the weight to the top, where it is automatically released, and falling, breaks the specimen, which in turn falls through the die into the pocket at the side of the machine. Having broken the specimen, it is necessary to measure the work required to cause the rupture. The cap covering the springs pushes down a light steel tube which is held by friction so as to give an accurate measurement of the deflection of the springs. This deflection is further multiplied by the aid of a multiplying lever and graduated scale.

The needle on the instrument is not in contact with the moving parts of the machine during the test. After the test is completed the needle is moved until its lower extremity makes contact with the tube compressed by the platen covering the springs; thus there is no inertia to be considered as regards the action of this pointer during the test. The pointer is so constructed that it falls away from the tube and is only in contact with the tube when held so by hand for the purpose of measurement.

To calibrate the machine the hammers are raised through successively increasing intervals of hight and dropped on the platen covering the springs. Corresponding marks are placed on the graduated scale as shown. Thus, the machine can readily be calibrated at any time with about ten minutes' work.

Let us now summarize the advantage obtained by this method and machine.

1. The method, by using small specimens, reduces the cost of test pieces and their preparation, thereby furthering the great production of tests and thus aiding in establishing a standard homogeneity test.

2. The small specimen permits of testing thin plates, both with and across the rolling, as well as the possibility of testing parings, or clippings from actual material used, or those nearest to any section subjected to the greatest known stress.

3. The machine affords an accurate method of measuring the work necessary to produce rupture under standard conditions, always maintaining the same speed of impact. The machine as manufactured

in this country will have a standard drop of 13 feet with hammers weighing 20 and 30 lbs., as these are the nearest English units to that used in the metric system.

The specimen will be ⅜ inch wide, 5/16 inch thick, and 1¼ inches long, with a saw-cut 1/16 inch deep. The die is 13/16 inch wide. The machine can be shifted from the one standard to the other without any material change. The specimens may be prepared either by hand or in quantity, by a small machine constructed for the purpose.

To determine the influence of the dimensions of the notch on the results of the tests Mr. Fremont made three series of tests; first, with depth equal to the width; second, width equal to twice the depth; third, depth equal to twice the width. In the bending test he found that double the width required the same maximum force to commence the rupture, but required more work to complete the same. Double the length required less force to commence the rupture.

Making these same tests by the drop of the hammer, Mr. Fremont found that a small variation in width was not discernible and only the case of double the depth created a difference in the results. The more fragile the steel, the less important would be a small variation in the size of the notch. Some results obtained by the Fremont drop test, compared with the other forms of testing, were tabulated by Mr. Fremont as shown in the accompanying tables. Table 1 beginning from the left, gives the result of the tension test, bending test, and shock test, with notch made both with a hacksaw and with a milling cutter. Table 2 is that of some non-fragile steels, showing the tension test to the left with the percentage of elongation and the average maximum and minimum work required to cause rupture by shock. From these results it is readily seen how fragile some steels are to shocks, while differing but little in the tension test, while steels passing the bending test also fail when subjected to the drop test.

The well-known imitativeness of the Japanese is instanced by the anecdote of an American machinery salesman who, in 1904, sold to Russia and Japan one each of a certain machine for marine work. Some time having elapsed without any additional orders, he made an investigation and found Russia's machine untouched and neglected in a navy-yard; but the situation in Japan was much different, for in a navy-yard in the latter country he found that the machine had been used as a model and many others built after it.

The first electric sign was erected at Broadway and Fifth avenue, New York, on the site of the present Flatiron building, by the Long Island Railroad Company and was an advertisement of Manhattan Beach.

The Apprentice School of the Thomson-Houston Electric Company.

Mr. M. W. Alexander, engineer of the Thomson-Houston Electric Company, of West Lynn, Mass., gave a very interesting address on the company's apprentice school at the Atlantic City meeting of the welfare department of the National Civic Federation, from which we make the following extracts:

The Thomson-Houston Electric Company at West Lynn, Mass.—a part of the General Electric Company—organized in February, 1902, an apprenticeship system, under which the boys of at least 16 years of age who have had a grammar school education and are desirous of learning a trade, are indentured as apprentices. The period of apprenticeship lasts four years, during which time the boys are taught the mysteries and arts of the different trades which are practiced at our factory.

Our aim is not only to make of these boys efficient machinists and toolmakers, patternmakers and carpenters, iron, steel and brass molders, instrument makers and electrical workers, but to develop a class of artisans from whom we can choose men for our leading positions in the factory, for assistant foremen, foremen and master mechanics. To hold such positions requires not only a knowledge of all the operations that have to be performed by hand or machine, but also a knowledge of the scientific principles that underlie the work, and of the ways and means of conducting the work in a business-like manner.

NATURE OF THE WORK.

With this aim in view, we recognized the necessity of educational development of the boys and incorporated right from the beginning in our apprenticeship system a school especially fitted for the needs of our apprentices. The lack of proper educational opportunities in the evening in the city of Lynn, such as, for instance, the city of Philadelphia offers in the Spring Garden Institute, was one reason which prompted our company to start its own school. The other reason was the desire to give to the boys eminently practical knowledge of the very kind which they will need later on as journeymen and foremen. We therefore selected our own engineers, draftsmen and shop foremen as teachers. These men know the needs of our factory and can impart to the boys the specific knowledge which they require in our own factory and, in a general way, in any manufacturing establishment of a similar character. The contact during school hours with the same men who direct them during working hours in the factory has a tendency to maintain better discipline among the apprentices, because school does not then appear to them as a separate institution, but as only one part of our apprentice work.

The school first met in the evening, when the factory closed; the boys assembled in the school rooms, partook of a light lunch furnished free of charge by the company and received instruction for about two hours. It soon became apparent that after a day's work the boys were too tired to reap the full benefit of the school instruction, and the evening school was therefore changed to a morning school. The blowing of the factory whistle in the morning is now the signal for the commencement of the school. The boys come to the school room physically and mentally rested. Formerly we had difficulty in keeping the apprentices in the school; now we rather experience difficulty in getting them out of the school room into the shop. The improvement in the results has been marked.

Each boy receives three years of instruction. He enters school after he has been an apprentice for about six months and he graduates from the school several months before he graduates from his apprenticeship. Each school year consists of forty weeks with two sessions of two and one-half hours each per week. The comparatively small amount of time devoted to instruction does not permit us to go very deeply into the various subjects which we teach. In fact, a large part of the teaching is merely a review of some of the grammar-school work, but applied to practical factory conditions. Experience has prompted us to devote a good share of the time to this review and to carry it back to the elementary stage of the subjects which we desire to review. The rest of the time at our disposal is devoted to subjects which either have not been taught in the grammar school at all or have been touched upon only in a general way.

The question will arise: Why should we, who have had no pedagogical training, attempt to review what has already been taught in the public schools by pedagogically trained teachers? With all due respect to our public schools, excellent as they are in the main—and nobody has a higher regard than I for a teacher and his efforts—I find from my years of experience that the public schools fail to teach the boy to think for himself and to think clearly and logically. The school has taught the boy a great amount of knowledge and has committed to his memory many formulas, but when it comes to the adaptation of this knowledge and of these formulas to practical uses, many a boy finds himself blocked, because he has not acquired the faculty of independent thinking. Our review, then, aims to instil in the boy the habit of independent thinking.

TEACHING TECHNOLOGY.

There is, however, another aim in our review of grammar - school subjects,

namely, to give the boy additional knowledge by giving him an insight into technology. To make my point clearer I shall take the liberty to outline briefly the course of study.

During the first year we teach English and mathematics, devoting one-third of the time to the former and two-thirds to the latter. In English, the spelling of technical terms is first taken up and then followed by short dictations explaining technical processes, describing materials and their properties and various kinds of apparatus. The boy, therefore, becomes acquainted in a general way with all our practical work.

Mathematics is the second subject which we review during the first year. We start with simple processes of addition, subtraction, multiplication and division, first of whole numbers and then of decimal and common fractions, finishing the year with proportion and percentage calculations Alternating with arithmetic, we review mensuration.

Only concrete examples are given by the teachers, who, as stated before, must aim to lead the boy on to independent thinking and to make him acquaipted with the very technical arithmetic which he may have to use as a shop foreman. It is only a test of the boy's memory if you ask him to solve "$3 \times 420 \times 12$," but it is an entirely different test if you put the same problem in the following manner: "A factory consists of 3 rooms; each room is lighted with 12 arc lamps, each of which requires 420 watts of energy. How much horse-power of energy will have to be provided for the lighting of the whole factory if 746 watts equal 1 horse-power?" In stating such a problem, we explain in the very briefest manner the meaning of "watt" as a unit of measurement of energy, and we also explain briefly the nature of an arc lamp, showing the outside appearance of the same and the inside mechanism. In fact, whenever a teacher speaks of a piece of apparatus or a part thereof, I insist upon having such apparatus or part shown to the boys, if this is at all possible. The boys will associate the picture with the name of the apparatus and will therefore retain the name better in their memory. I do not expect that the boy will learn fully the meaning of a watt of energy, or a volt of pressure, or an ampere of current, or for that matter, the operation of an arc lamp, the characteristics of an incandescent lamp, or the principles that govern the running of a motor. The terms "watt," "volt" and "ampere," "arc lamp," "incandescent lamp" and "motor" will become, however, familiar to him by frequent usage, and when, later on in the teaching of physics and magnetism and electricity, these same terms are brought before him again, they will appear to him as old acquaintances and will therefore make their study so much easier to him.

I desire to give one more illustration, taking this time mensuration as my subject. A problem may be commonly stated as follows: What is the weight of a steel rod ½ inch in diameter and 50 inches long? We state the problem in a different manner: "The machine shop is ordered to produce 75 steel pins, each to be ½ inch in diameter and ¾ inch long. These pins are to be cut from a long steel rod and the tool for cutting off the pins will waste 1/16 inch of material between each two pins. How long a steel rod will be required, and what will be the weight of the same?" This is a problem which we meet in everyday factory life and which involves nothing else than plain multiplication and addition. It is simply a question of multiplying 75, the number of pins, by ¾ inch, the length of each pin, and adding to it $74 \times 1/16$ inch, which we have wasted by the cutting-off tool. The whole will give the length of steel rod required. Now this length is multiplied by the area of a half-inch circle to obtain the cubical contents, which, when multiplied by the specific gravity of steel (a figure which we give to the boy), will give the total weight.

TEACHING FACTORY ORGANIZATION.

The last few weeks of the third year are devoted to lectures on factory organization and factory systems. A boy too often acquires the idea, which sticks to him even after he has become a journeyman, that a foreman is after all nothing but a slave driver, whose chief duty is to obtain from the man the last ounce of work. We endeavor to show to the boy that the foreman is only one link, though an important one, in the big chain, which cannot operate if even the smallest link gives out. As soon as the boy begins to realize this, he begins to understand that even his own little efforts have their importance and are needed in the carrying on of the whole work; he will become a supporter rather than an antagonist of the foreman.

I attach quite an importance to these few lectures and to the effect they should have upon the future working-men. An ambitious working-man may inquire the reason for doing a certain thing in a certain way. What is the usual answer that most foremen will give him? They will tell him in a more or less polite way that it is none of his business; that he should bother about his own work and not waste time by asking such questions. I believe most decidedly that it is an ambitious man's business to understand, in a general way, the conditions that surround him and the reasons for carrying on work in the way in which he is directed to perform it. A question asked in the right spirit deserves some answer in the same spirit. The man will be benefited by it and the company will be better off for that.

I think it of sufficient interest to state here a psychological element in our school work. If we ask a boy to figure out the weight of a piece of brass three inches long by one inch in diameter and tell him that he is wrong if his calculation does not give the proper figure, he may assume an attitude of antagonism to the teacher. We give to the boy a piece of brass, let him measure the same and sketch it on a piece of paper and calculate the weight. We then hand to the boy a pair of scales to check his own results. If now the scales tell him that he is wrong, he will feel rather ashamed of himself and re-calculate the problem with the earnest desire of arriving at the proper figure. The boy has, so to speak, a greater confidence in the veracity of the scales than in the veracity of the teacher.

The cost of equipment in the training room has been about five thousand dollars, and an additional three thousand dollars will be spent within the next half year for the purchase of new machines. These machines are a good investment and can be used anywhere in the factory.

"The General Electric Company," Mr. Alexander said, "does not believe in letting anything go to waste. No money is spent in a purely sentimental way; there is always a straight business proposition at the bottom of things. If that were not the case I would not care to help in the work."

Persistent Carelessness in Shipping.

Consul-General Ridgely, writing from Barcelona, again calls attention to the evils of careless correspondence and cites concrete examples to support his case. He writes:

I must again call the attention of American shippers to their neglect in not promptly forwarding bills of lading covering shipments of merchandise to Spanish ports. In the steamer "Montserrat," which arrived at Barcelona from New York, January 18, there were no less than four important shipments of American merchandise which still remain in the custom-house (January 31) unclaimed, and liable to be sold at public auction because of the alleged fact that the consignees have not received bills of lading covering the shipments in question, two of which were consigned to order and the other two to addresses classed as "unknown" at the custom-house. As has been heretofore urged in reports from this office, shippers should be careful to advise their consignees at the very moment of shipment by registered letter, with the bill of lading and full particulars as to the shipment inclosed. Especial attention should be paid to the recommendation as to the registration of these letters, for when such letters are delivered there can be no excuse for a claim by the consignee that he did not receive the bill of lading, as has sometimes been the case.

Letters to the Editor.

How Much Responsibility Goes with the Work a Man Does?

I think that the article by J. L. Gard on "The Liability of the Patternmaker" deserves more than passing attention. While it is true that each of such cases has to be met as it comes up, and that because of the differences in the conditions and in the people who have to be dealt with, no general rule can be adopted, yet at the same time it is a good thing for a man to have thought out the general points ahead of the time of need.

Most firms and most individuals are ready and willing to acknowledge what they think to be a fair responsibility for their acts either of commission or omission, as applied to their business. The trouble seems to be to decide as to what a fair responsibility is. On the one hand it is often argued that a man is morally responsible for all of the consequences of his acts.

This line of talk is generally delivered by the man who wants someone else to reimburse him for some real or fancied damage. Again it is said that after a thing leaves a man's hands and is accepted by the other party, all responsibility passes with it, and the first man is clear. This line of talk is apt to come from one who wishes to evade any reimbursement for real or fancied damages. Somewhere between these two extremes must be the ground that is fair to both sides; ground that a fair-minded man, who wants to treat the other fellow right but does not want to be "gouged," would like to know the boundaries of so that he could occupy it if the necessity should arise.

For example, after a steam engine has been used for a number of years, the owner of it has a test made and discovers that it is a "steam eater," and on investigation finds that through some mistake the valve was not properly made and set. He has it seen to by the makers of the engine, who find for some reason that the work had not been properly done in the shop.

In such a case I believe that most firms would not hesitate about putting the engine into the shape it should have been originally without making any charge for the work. I do not believe that many firms would make good the loss due to the uneconomical use of the steam prior to the fixing.

It needs but a brief inspection of some of the "guarantees" which are found in makers' catalogs, and of notes put on many quotation blanks and billheads, to show that the maker does not agree with the views on this subject as held by many of the buying public.

Taking the engine builders for illustration, it is common to find that the material and workmanship are stated to be first-class, and that anything found to be not so within one year will be replaced. Here is clearly shown a belief that the liability of the maker is a limited one, for if it were not so why is the time limit put in? It is very evident that most of the makers want to make engines suitable for their trade. If an imperfection should pass through they consider that it is the duty of the owner to know of it in a reasonable time, for if it is a real imperfection use should develop it enough to allow it to be known. If a part is actually defective, as for example a casting with a draw or dirt in a place that will unfit it for the maximum work it should do, and the piece breaks the case is a simple one; but suppose the piece breaks without any evidence of imperfection, and the owner of the engine claims it is defective in that it is not strong enough to do the work it should be able to do?

How much perfection of design should a manufacturer be held responsible for?

A boy starts to work in a machine shop. He is full of energy and gall. He is immature and ignorant, and too young to know it. He is willing and ready to undertake anything. He is so inexperienced that he does not know the difference between the poor work he produces and the good work produced by others. He breaks drills and ruins files, and his work has to be touched up by others. "Confound that worthless boy. I'd like to wring his neck. If he had to pay for this himself he would learn a thing or two. If I was running things I would make him pay for it, and then I would kick him so far that he would never get back." That is only the growling of the man who has to work after the boy.

If things get to be intolerable, and the boy is discharged, is that to be considered as collecting damages, or is it simply taking out insurance against future damages?

A machinist enters a new shop. He is put to work, and takes much more time than he should on work of that kind on the first few pieces. Does his claim of being a first-class machinist require that he should pay for the extra time?

The machinist starts a shop of his own and begins to make engines, which he thinks will be world-beaters. He puts in good work and good material, and the best knowledge of engines that he has. He sells numbers of these engines to people who buy them and use them without knowing any more about whether the design is good than he does. As time goes on he learns more about good design and makes better engines. He then knows that the design of the first engines was as poor as it could well have been. Is he under any obligation to the people who bought those first engines? If he is, how much knowledge and experience must he get before he crosses the line where his responsibility ceases?

Suppose the view is taken that he is responsible for the first poor designs; what is the extent of that responsibility? Should he replace the first engine with one of the latest design, or should he make good all of the losses which it might be estimated have come from the difference in design? If he should do either or both, how much more can he improve before the same thing should be done again?

Mr. Gard's experience, as related in his interesting article, was told to several men, one at a time, and to begin with they all took the view that he should make good the loss. They evidently viewed it just as did the party who had the pattern made. One of these men was a machinist.

"You think that in fairness he should pay for a new casting?" I did not tell how the matter had been settled, but had told the facts as to the mistake having been made, and asked for an opinion as to what would be fair in the matter.

"It certainly looks that way. You put it as though it had been me that he had been doing the work for, and I think that I should expect him to furnish me with a new perfect casting. He is running a pattern shop and advertising to do good work, and if he fails to do it he should make it right."

"Then you would hardly consider that he was making it right when he put the pattern into proper shape without cost?"

"No. I was not to blame for making the mistake. He did it. It is his mistake."

"Where does the foundry come in?"

"I don't see that they come in. They made a good casting from the pattern as furnished. If it had not been a sound casting they would certainly have had to replace it, and to have kept on making until they got a sound one or else not get anything."

"If you had orders to turn a piece a certain diameter and length and made a mistake, and made it something else, and that piece was put into expensive machinery, and because of the mistake wrecked the machine, you would then think it your duty to pay for the machine?"

"The foreman should look to it that I got it right. That is part of his business. If I don't suit him he will let me go."

"But if you were running a little shop of your own, and did the work yourself, and there wasn't any foreman, then you would think that you should pay all damages done, even if it took the little shop?"

"No, I do not. The man who gets a piece could have measured it himself, and so could the man who put it into the machine, and they could have pulled the machine around and seen that everything was clear before starting up. Every man who ever had anything to do with

machinery knows that it is not safe to start up unless it is done. Every man is liable to make a mistake once in a while. Even the best of men do it."

"Suppose the man did measure the piece as well as he could, and thought it was all right?"

"I think that should let me out entirely. If he wasn't able to do it right he should hire a man who could. I don't know whether I even ought to make him a new piece if he said that one was all right."

"If that would let you out why should you want to hold a patternmaker responsible for the results that come from his mistake? He is liable to make mistakes like the rest of us."

The machinist smiled as he saw where the reasoning led to. "I think I may have been a little fast about the matter at first. There are many sides to it when you come to look at it. What do you think about it?"

I had been on several sides of the subject in a most practical way, and like the rest of mankind I had wished that all the responsibility belonged to the other fellow in all cases, while in most cases it was insisted that it all belonged to me. This had led me to have views on the subject, and perhaps it was one of the reasons why I was attracted by the case of Mr. Gard.

"I think that in all cases where the price paid is simply a fair price for the time, machinery and material used, the man getting the work done is responsible for its use. When the man doing the work holds himself responsible for the material and workmanship to the extent of furnishing a new piece, if either is shown up to be defective I think he is doing his full share. It is the part of the buyer to recognize that mistakes are liable to occur, and to take reasonable precautions to guard against them. The manufacturer does so by having the work inspected. A workman is held only for a reasonable exercise of his skill, be he lathehand, foreman, designer, superintendent, or general manager, and why should the owner of the shop be held for more than that unless he expressly guarantees to deliver more?"

W. OSBORNE.

Interchangeable Boring-Bar Cutters.

The troubles experienced by some shops with their boring bars and cutters if recorded would make a book of several chapters. I write this with the hope that it will be followed up by some of your contributors with their experiences.

The boring bar *L* shown in Fig. 1, I find unsatisfactory because the hardened edges of the cutter *G* at *A* cut the softer metal of the bar *L*, and thereby allow the cutter an uncertain amount of side play in the slot, which is always doubled in the hole being bored. When this side play becomes so great as to allow the cutters to bore a hole larger than standard size, it is necessary to mill down the flats on the bar and make a new set of cutters throughout, which is very expensive, as the bar has to be out of service while this is being done.

In Fig. 2, we have the boring bar which is theoretically correct, but practically a failure for the reason that it is next to impossible to drill the hole for the hardened pin *M* exactly through the center of the bar *L*. I think any toolmaker will agree with me in this statement, if he has ever tried to drill a ¼-inch hole through the center of a ¾-inch round bar of tool steel at right angles with the axis. I have overcome the defects of Figs. 1 and 2 by constructing our boring bars as shown in Fig. 3.

I make all of our bars, keys and centering pieces of low-grade tool steel, and our cutters of Jessop steel. All the work on these bars except locating the centering pieces, drilling and reaming the taper pin holes *J*, and finishing the end of the keys *K*, is performed on the milling machine.

For grinding cutters for these bars, I use a short bar *S* made of tool steel with hardened centers and with a slot as shown at Fig. 4. It was necessary to make this bar first, in order to originate what I will call the master cutter *M*.

The key *K*, master cutter *M*, centering piece *N* and screws *B* and *C* were hardened and assembled in the short bar *S* as shown in Fig. 4. It was next put into the grinder, and the master cutter *M* was ground until both ends were trued up. The micrometer hight gage was then set to just touch the ends of the master cutter *M*, and the reading noted. The master cutter was then changed end for end in the slot, and the hight again taken. It was then readily seen which way and how much the centering piece *N* was out of center. By continued grinding, testing and adjusting of screws *B* and *C*, we were enabled to set the centering piece *N* so that the convex projection was within 0.0001 inch of the center.

This same master cutter is used to locate the centering pieces in the boring bars as follows:

The boring bar *L* is mounted on dead centers and straightened if necessary, then the centering piece *H*, master cutter *M* and hardened key *K* are put in place, and the key driven up lightly. The micrometer hight gage is again brought into service, and by tapping the centering piece *H* with a light hammer, the mastercutter is brought to a position where the variation in the micrometer readings taken from both ends of the master cutter is within the 0.0001 inch limit.

The key *K* is then driven up tight, and the master *M* is again tried with the micrometer, and, if still within the limit, the bar is ready for drilling for the taper pin *J*.

After fitting the pin, the centering piece *H* is hardened, and if the hole has contracted in the hardening, it is lapped until the taper pin *J* will enter to the same depth as it would previous to the hardening.

If on the contrary, the hole has expanded, the hole in the bar will have to be reamed larger.

Boring bars and cutters made in this way, will bore within 0.002 inch, if the

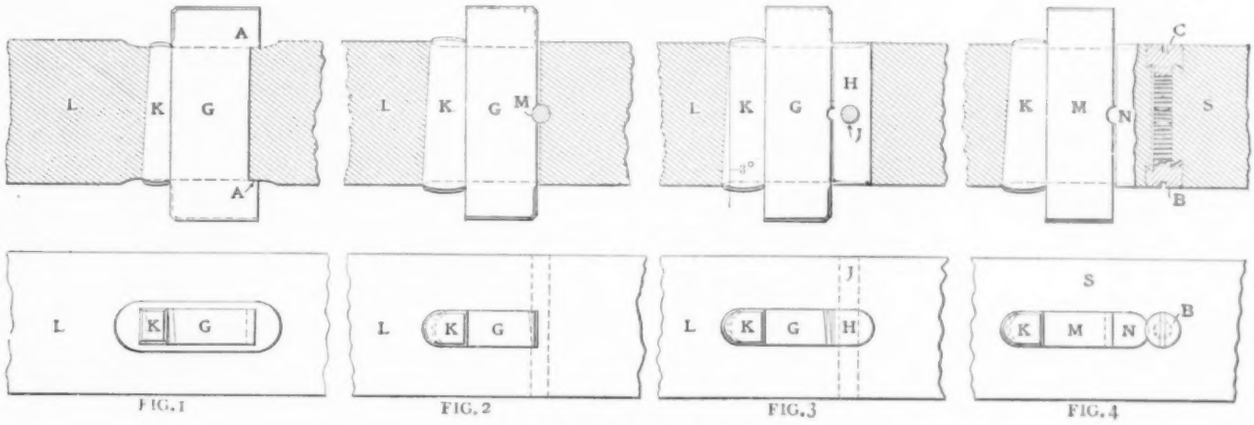


FIG. 1 FIG. 2 FIG. 3 FIG. 4

INTERCHANGEABLE BORING-BAR CUTTERS.

bars are kept straight, and are a good fit in the supporting bushings. This I think is near enough where holes are reamed by hand after boring. A. V.

Thrust Bearing and Commutator for Gasolene Launch Engine.

I see G. E. L. at page 121 wants information on gasolene engine parts, and I can give him all he wants to know.

As to the thrust bearing, the best is a ball bearing, made by a brass washer

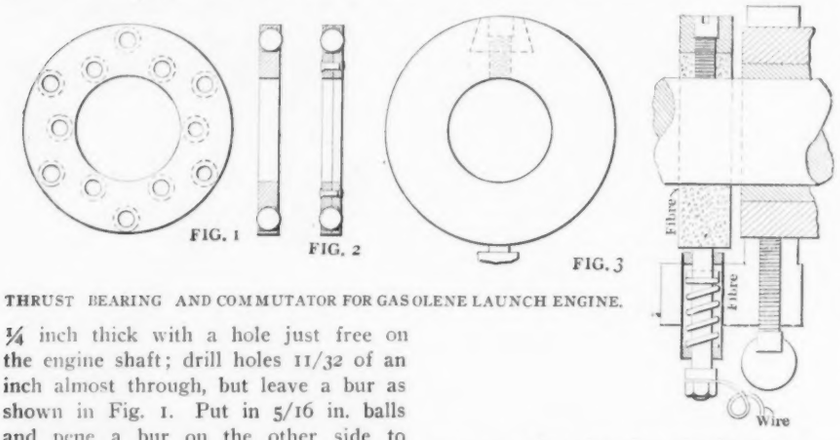


FIG. 1 FIG. 2 FIG. 3

THRUST BEARING AND COMMUTATOR FOR GASOLENE LAUNCH ENGINE.

¼ inch thick with a hole just free on the engine shaft; drill holes 11/32 of an inch almost through, but leave a bur as shown in Fig. 1. Put in 5/16 in. balls and pene a bur on the other side to hold the balls in. The balls should be free in the hole and project 1/32 of an inch on each side. The thrust bearing should be put on the engine shaft next to the main bearing, and the thrust collar should be just free on the shaft but firmly attached. It is better to put a hard steel collar on each side of the ball ring. Figure 2 shows another way to make the ball holder, which is by taking two washers and drilling holes for the balls nearly through them, and after placing the balls in their holes to rivet the two washers together as shown.

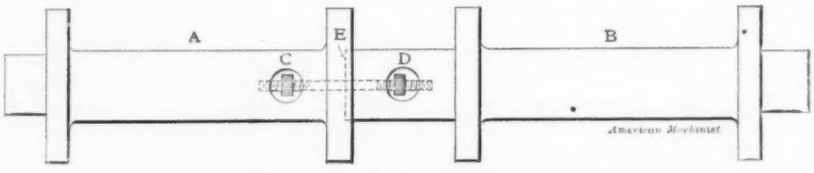
With reference to the igniter, i. e., commutator: The kind which should *not* be used is a cam lifting a spring off and on to a contact point, this device being always treacherous. I use a collar of fiber ¼ inch or more in thickness having a hole to fit engine shaft and being from 1 to 1½ inches larger outside. On small engines I put a brass set-screw running down to the shaft with a large head partly countersunk, then filed off smooth and even with the fiber.

It is, however, better to dovetail a brass segment into the fiber, as shown in Fig. 3, the brass forming the contact as the brush comes around. A brush to make contact on the set-screw or the piece of brass, may be made from a strip of spring brass, the other end fastened by some means which insulates it from metal, such as being screwed to a piece of fiber, which is held by other screws at a sufficient distance from the screw holding the brush.

The modern brush holders have a rocking movement to time the ignition, which is effected by a clamp upon the circular extremity of the main bearing, which clamp carries a small tube, in which is a brass rod, or other brush pressed by a light spring; a handle with a threaded rod, which can be formed from a set-screw, permits of readily changing the position of the brush holder, and therefore the point at which the circuit is closed and the ignition effected. If this is not sufficiently detailed, I can furnish additional particulars. These forms of commutator and brush holder can be forgotten for a year at a time, but they should, however, be cleaned every year whether they need it or not; they will be found to be better than most of the devices sold for this purpose. E. Q. WILLIAMS.

Making a Pattern too Long for the Lathe.

Some time since a job came in, calling for a pattern similar in outline to the illustration but too long to swing between



MAKING A PATTERN TOO LONG FOR THE LATHE.

the centers of the lathe. It was made solid and the parts *A* and *B* turned separately, with *B* seated about ¼ inch into *A* as shown by the dotted lines at *E*, and the whole was fastened with a stair-rail bolt.

To do this a long hole was bored, an easy fit for the bolt, into the center of both *A* and *B*. The two holes *C* and *D* were bored with a diameter quite a little larger than that of the nuts that go with the bolt, and intersecting the first holes, and going somewhat beyond, so that the nuts could be dropped in to fall central with the bolt.

The bolt was then placed in part *A* of the pattern, and secured in the nut, when part *B* of the pattern was slipped into place, first placing the nut with corrugated edges in hole *D*.

Owing to the peculiar form of a stair rail bolt with two nuts, one of them being round with ridges or corrugations, the two parts of the pattern could be securely clamped together by inserting a short rod or punch in the hole *D* against the ridges on the edge of the nut, and then striking it with a hammer. Lastly the two holes were plugged and the pattern was ready for shellac. JOHN RICHARDSON.

Why Sounds Differ in Pitch.

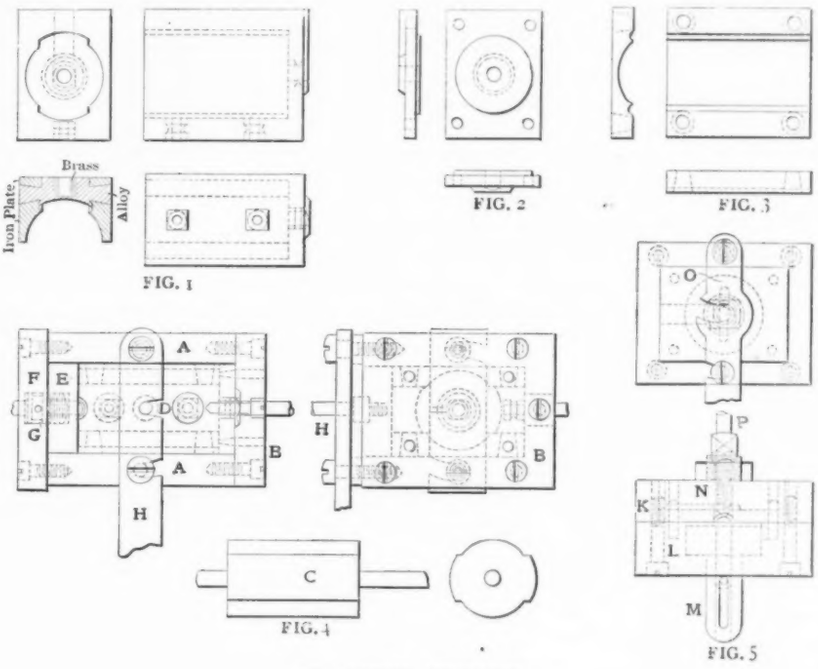
The explanation at page 109 how an echo may be in a higher key than the original sound was instructive and brought to mind another interesting thing concerning sound. Sound vibrations are, of course, air waves and if the receiver of the sound, in this case the ear, should move in the direction the sound is traveling, the length of the wave, relatively to the receiver, is increased; if it should move toward the origin of the sound, naturally the length of the wave is decreased, relatively of course, to the drum of the ear. If, say, in the period of a second 500 vibrations take place and the sound travels 1000 feet in that time, then the length of each wave would be two feet. Now, if during that second the receiver were to travel 100 feet toward the origin of the sound the distance the sound would travel during one vibration would be $\frac{1000 - 100}{500} = 1{:}8$ feet. The shorter the air wave, the higher the note. So if the receiver moves toward the origin of the sound the pitch of the sound appears to be in a higher key than it really is; if moving away the sound is apparently pitched lower. If it were possible for the receiver to travel at one-quarter the velocity of sound, five-fourths the original number of vibrations would be felt when traveling toward the origin of the sound and three-fourths when moving in the same direction as the sound.

Ordinary movement being so slow, comparatively, the difference in pitch is not usually noticed. One of the few places where the effect is noticeable is a railway carriage, when two trains are passing. When the trains are nearing each other the whistle of the approaching train sounds in a higher key than when they are leaving each other. The difference in pitch is quite distinct and can readily be distinguished; of course the change is very sudden and at the instant when the hearer passes the locomotive whistle. H. T. MILLAR.

Manchester, England.

A Die-Casting Job.

As the tools for this class of work are increasing perhaps a few sketches of appliances for die-casting a generator box and cap may be of interest. This generator box is used in telephone call boxes for magneto ringing, and one feature of the box is that it is dust proof; it also is very strong, compact and simple, having two iron pole plates, two metal bushings for the spindle bearings of the armature, and two square bushings of brass for fixing holes. The box proper is shown in Fig. 1 and its cover in Fig. 2. Fig. 3 shows a pole plate.



DIE-CASTING APPARATUS.

The construction of the casting tool is shown in Fig. 4. It is a mild-steel forging *A* machined as indicated. One end is fitted with a cap *B* fixed on with five screws and two dowel pins to locate it, and having a hole to fit the spindle of the mandrel *C*. The cap has four locating pins to keep the pole plates the right distance from the end. The plate *D* is to close the top of the die by resting on the pole plates. The end plate *E* is to close the end of the die when the two plates and the mandrel are put in ready for the casting operation. The plates are machined to gage. The two armature-spindle bushes are made in a turret lathe and are also to gage especially as regards length, as they gage the mandrel when put in. It will be noted that there is a bead on the bush and it is milled on the sides; the bead is to keep it from moving endwise and the milled sides are to keep it from turning when the metal is cast.

The operation preliminary to casting is to put two plates, Fig. 3, in the die Fig. 4, slide one bearing on the mandrel spindle, push the mandrel in place against the cap end, slide end plate *E* against the mandrel and clamp with the clamp *F* by unscrewing the stem *G*. The clamp plate swivels on the stem so as to detach easily, it being slotted at either end so as to swing clear of the two screws which normally retain it in position. The plate *D* is clamped by a swinging lever *H*, which also has a stem that by unscrewing forces the plate against the two pole plates. The stems mentioned have wood handles on account of the parts getting heated, and the two stems that are used to carry the square bushings are also fitted with wood handles. The pole plates have four tapered holes cored in for the metal to flow in, which holds all together when cast.

The tools for casting the cap for the box are shown in Fig. 5. The construction of the die is similar to that for the box. The piece *K* is cut out the shape of the cap right through and fixed to the piece *L* by four screws and bored out to suit the mandrel *M* which is the size of the internal part of the box and a little shorter than the recess so as to form the shoulder of the cap. The four pins are to form the fixing holes in the cap. The slot in the mandrel *M* allows the cap to be forced out when cast by using the mandrel as a knockout. The plate *N* is pushed against the bearing bushing and is clamped by the square-head clamp screw in the strap *O*. The stem *P* is fixed in the plate *N*, and the clamping lever *O* and the square-head screw are slotted so that it can be easily released. The half-section through the box, Fig. 1, shows the brass bushing and the method of holding the plates together. The raised portions at the end of the box and cap are for oil holes.

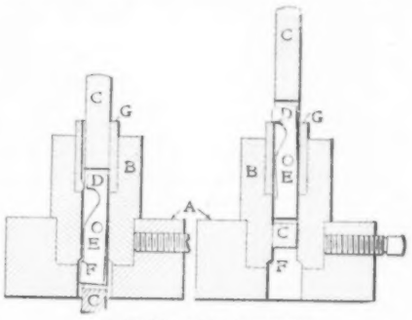
C. PETITJEAN.

London, England.

Cutting Oil Grooves.

The accompanying sketches illustrate a slotting, or oil-groove cutting fixture, which was made to cut oil grooves in phosphor-bronze bearings.

A is a base made of cast iron, into which the piece *B* is held by a set-screw in the side. *B* is made of tool steel, bored to fit the bearing *G* with the lower part bored to fit the cutter arbor *C*. *C* is tool steel slotted to receive the cutter *D* which oscillates on the pin *E*. The arbor *C* is made slightly smaller than the hole to be slotted so as to pass through freely after the cutter has done its work. The cutter *D* is so made that the forward part



CUTTING OIL GROOVES.

just fits the hole in *B*, thereby holding the cutting edge to the proper depth to be cut. The length of slot is determined by the length of the bore of *B* which releases the cutter as soon as the recess in the cutter comes opposite the point *F*. It will be noticed that the cutter is recessed very deep near the cutting edge; this is to take care of the chips. This tool may be used on an ordinary arbor press. The arbor is forced straight through and drops out after the cutter is released. Four sizes were made, ½, 5/8, ¾, and 7/8 inch. It has proved to be successful in every respect.

W. A.

Interest on Delayed Shipments.

The question of ethics between manufacturer and dealer which you raise at page 883, Vol. 28, Part 2, seems to be susceptible of attack from several points of view. A man who builds special machinery even of moderate size, will begin to put out money about four months before it is completed. If he is selling direct to a user he will probably receive monthly payments on account, but if he is selling through a dealer, as in this case, he probably carries the job clear through before he gets a cent, and of course the interest on his investment is something he has to stand. If this is the present case, he probably thinks that if he stood the interest on his investment for five months longer than he expected, his loss is

greater than the dealer's, and it ought to be considered as evidence of his good intentions.

On general principles if one person causes another loss, he is responsible only if he could have prevented the loss. Unavoidable delays on the part of people on whom the manufacturer depended would be a sufficient excuse to clear him from damages of any kind, but if the delay was caused by the manufacturer pushing other work in preference to this job, then the dealer would consider himself justly injured unless the case was analogous to a scrape that I got into once. I was asked by my next superior to do some extra work nights and Sundays, for which the company was to pay my bill. I asked what rate would be accepted by them, but he refused to name a rate, saying that I was to charge whatever I considered fair. When the work was done, I figured that since they were paying me about 60 cents per hour for my regular work that they ought to stand for 50 cents for extra work, especially as I had lost one or two chances to make a dollar an hour in the meantime. When my bill reached headquarters it stuck, and I had to compromise at 30 cents, but the point came when

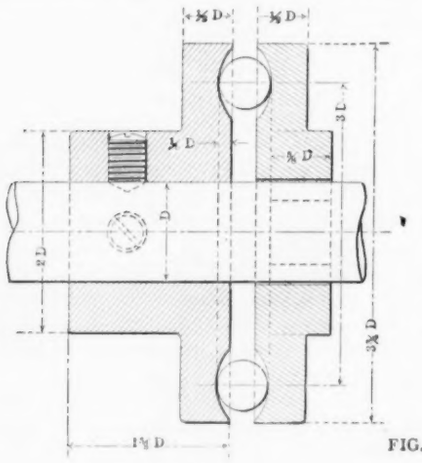


FIG. 1

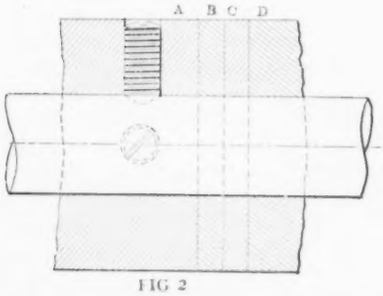


FIG 2

my boss told me that the reason he would not make a price was because he had to get the work done and he thought I would not do it if I knew I would get only 30 cents per hour. In the case you cite the easy remedy, if the dealer is disgruntled, is for him to specify just what he wants in his contract. If he does not do that it is probably because he is afraid or knows that his terms would not be accepted, and if that is the case he hardly ought to cry baby over a few months' interest.

ENTROPY.

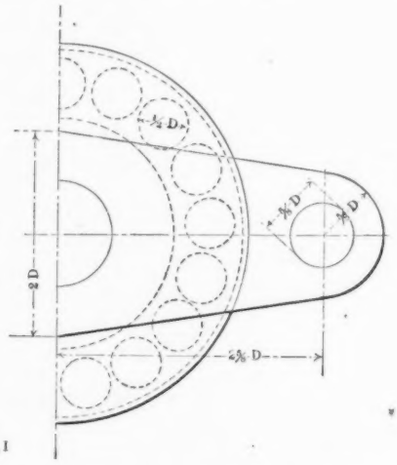
Thrust-Bearings for Gasolene Launch Engines.

In answer to an inquiry published at page 121 in regard to a thrust-bearing for a four-horse-power gasolene-launch engine I offer herewith two types of thrust-bearings that have given good service in practice.

It will be noticed from the sketches that all dimensions are given in terms of *D*, *D* being the diameter of the shaft. Fig. 1 represents a ball-bearing to be bolted to a boss cast on the after end of the bed-plate, or, if the bed-plate is already built without the boss, the forward part of the bearing may be attached to the bed-plate by ⅝-inch studs tapped into the bed-plate, or to brackets, according to the shape of the bed-plate.

Both parts of the bearing are best made of tool steel or of mild steel case-hardened. This bearing may be lubricated with oil, graphite or both.

A casing of wood or sheet metal over the bearing would be of great assistance



THRUST BEARINGS FOR GASOLENE LAUNCH ENGINES.

in keeping dirt and grit out of the ball races. The steel balls may be obtained from any first-class supply house.

Fig. 2 is another and simpler type of bearing which is used on many small launch engines. A brass and a steel ring are placed on the end of the crankshaft between the bed-plate and the coupling or sparking cam, as the case may be—*A* representing the coupling, *B* a brass ring, *C* a steel ring and *D* a boss on the bed-plate.

For small launches, where the tendency to heat is not great, it gives good service. Backing is so seldom necessary with small launches that a shoulder on the crankshaft inside the after main bearing is the only provision usually made for it.

A. H. NOURSE.

A Knock-off Arbor.

I noticed a description of a knock-off arbor at page 188, for holding threaded work in the lathe. It was a very clever idea, and similar to one which we use in our shop. I enclose sketches of our arbor which may be a little simpler, but equally good. This knock-off arbor was used for facing the oil-cup covers *A*. The arbor consisted of a body like *D*, Fig. 1, recessed for the plate *C*, which was a sliding fit and held by the taper pin *B*. The work was screwed into the holder by hand, and a light tap upon the pin

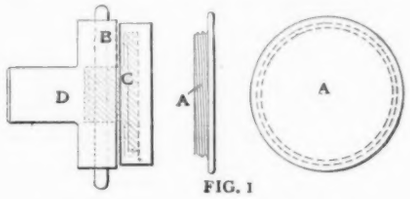


FIG. 1

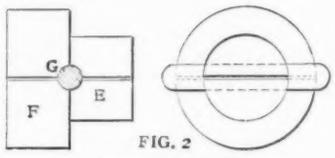


FIG. 2

THE TWO ARBORS.

forced the plate against the work. On completion of the operation a light tap upon the small end of the pin released the plate, and the work could easily be unscrewed. The pin was burred over on the small end, to prevent it from getting out and lost.

Another little arbor which we use here may be new to some of your readers. It is used mostly in connection with the dividing head on milling machines, when cutting the side teeth in milling cutters or any work where an arbor must not extend beyond the surface of the work. Fig. 2 is a plug arbor, the small end *E* is turned to fit the work, while the large end *F* is gripped in the chuck. A pin *G* ⅝ inch diameter, forms a pivot for the halves of the arbor to rock on.

After the hole is drilled for the pin, the arbor is sawed in through the center of the hole. The work fits over the arbor at *E*, and when gripped in the chuck at *F* the pin acts as a fulcrum, holding the work at *E*. This has proved to be much more secure than the old way of expanding a mandrel with a taper screw.

TEXAS.

Care of the Hands.

The subject of washing the hands has been presented in various ways in your paper, so that possibly but little more of interest can be said on that subject. However, there is another entirely different proposition to be dealt with in this connection, in which prevention is better than cure, if such a thing is possible; but when the hands receive such treatment as

they must to be cleaned of machine grime, they are in prime condition to both crack and chap, and a ready and sure cure for these very annoying cracks which come in the ends and joints of the fingers I will now give.

With a sharp knife pare down the thick dead skin each side of the crack as thin as possible without bleeding, in order to prevent concentration of strain in the crack with every movement. Then with a small lump of the old-fashioned adhesive salve (enough of which can be purchased for 25 cents to last a lifetime), softened by heat and applied to the crack, and a piece of tough paper simply stuck on outside, the crack will be cured quickly, sometimes in a single night, but usually in 36 to 48 hours. This application will resist everything but oil and heat, and with any kind of care will not wear off until it should come off.

For chapped hands I have tried many things, but have yet to find an equal to mutton tallow; which, however, must be fresh, as, if old, it irritates instead of healing. It is prepared by simply melting mutton suet, which may be had at any butcher shop. The tallow being tried out by gentle heat, is strained through cloth into a suitable mold for the cake, as, when cold, it is quite hard. After washing and thoroughly rinsing to remove all soap, rub the chapped surfaces with the cake of tallow and thoroughly heat it at the stove.

CHARLES S. BEACH.

Split Dies—Keeping Track of Press Tools.

Among the many excellent articles on punch and die work which have appeared in the AMERICAN MACHINIST during the last year, none have been inserted on the above subject, and so this is put in to fill up the gap.

The object of the two-piece or "split" die, as it is usually called, is two-fold: First, to reduce the cost of making, which it accomplishes in two ways; on account of the ease with which it can be machined out, and also because the work can be done by a cheaper class of labor, for it does not take so good a man to mill or plane out a piece of work, as it does to drill, chip and file it. There is also another advantage; should a part of the die be broken, it is much easier to repair it than to make a whole new die, especially when the shape is similar to the one shown in Fig. 2.

The steel is tongued and grooved as shown plainly in Fig. 1, the tongue being placed well toward the bottom of the die, so as to give as much wearing surface as possible without interfering with the groove. A 1/16x3/8-inch tongue is amply strong for any ordinary blanking or trimming die. The joint is milled or planed, the two halves are fitted together and a 1/2-inch dowel pin is inserted near the end to prevent end movement when in use. The die is laid out in the usual manner, then taken apart and machined either by milling or shaping, whichever is best.

After being hardened the dies are fitted and held together by a die shoe or holder. The joint in the center of the dies does not show in the least on the work; the punch of course being made in the usual manner. This method of making a die is particularly adapted to trimming dies for drop-forgings, for either cold or hot work, and has this advantage; as the forging die spreads in use, you can adapt the trimmer to it by inserting a shim in the joint, and thus save working the die over, as would otherwise be necessary. The die, Fig. 3, shows how well adapted this method is to a job where the shape is such that there is a liability of breaking.

"Split" dies have been made for clock hands, gage points and work of this kind from time immemorial, but it is only within the last few years that I have seen dies of almost every shape made that way, even round dies on account of the ease with which they can be spread to suit the trimming of the forgings.

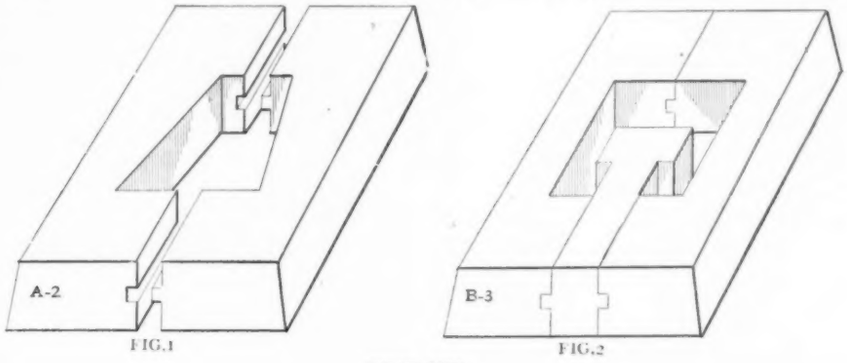


FIG. 1 FIG. 2

SPLIT DIES.

I will try and send you a few articles on drop-forgings, to show the adaptability of the "split" die to that class of work.

You have told us in the last year lots about press tools: How to make them; how to use them; how to harden them, and what we could make with them after they are done. Now tell us some more. Tell us how to take care of them, how to put them away so that when Dick goes to get a set, he won't come back and tell you that Tom has put it in the wrong place, or mislaid it, and he can't find it. Then you tell him to go back and hunt for it until he finds it, and it generally ends by your having to go and find it yourself, and sometimes (at least in one case I remember) you had to have a new punch and die made, just because you didn't have an iron-clad system, but had to trust more or less to the men who used it.

I will try and tell in a few words what I have found to be the best way for taking care of tools. Not that I think it is *the* best way, by any means, but it is the best one that I know of, and I would be very glad indeed to find a better one.

The system, if it be worthy of the name, is this: Mark every rack with a letter as *A*, *B*, *C*, etc., and then every shelf in the rack with a figure number, so that the compartments of shelves used for holding the tools are as *A*-1, *A*-2, *A*-3, *B*-1, *B*-2, *B*-3, etc., then keep a card-index of the tools, designating on the card the rack and shelf number of the tools. It is then an easy matter to locate the tools provided that the press hand who put them away was careful to put them in the proper shelf. There is only one bad feature about it; if you have, say, 5000 dies and one does get mislaid, it sometimes means a long search before it is found.

One thing more I should like to see discussed, and that is, which is the best, or the way most in use of holding dies in the shoe? I would like to hear from others upon this point. J. L. LUCAS.

Milling Steep Pitch Worms—Errata.

In the second paragraph of the article under its above title, at page 356, for "3348 inches pitch diameter and 3825 inches outside diameter," read 3.348 and 3.825 respectively.

A Taper Gage.

At page 321 H. E. R. Manbrand makes some further explanations in regard to his taper gage, to some of which I take exception. He speaks of the section of the cone which forms the points of contact with the gage as being parallel to the axis, which, if true, would make the section a hyperbola, as he says. But the section is not parallel to the axis, but is more nearly parallel to one of the elements of the cone, which makes the section a parabola.

The case illustrated in Fig. 2 has no bearing on this case. The conditions are entirely different, as in effect the V is made to the same taper as the frustrum of the cone, for the points of contact at the small end are closer to the bottom of the V by an amount equal to the difference between the radius at the large end and that at the small end. This section, which would pass through the vertex, would be a triangle, and of course the sides, being

straight, would fit perfectly under the conditions shown in Fig. 2.

However, leaving out all question of parabola or hyperbola, I can see that such a gage would be useful where the limit of variation allowable is not too small.

F. F. F.

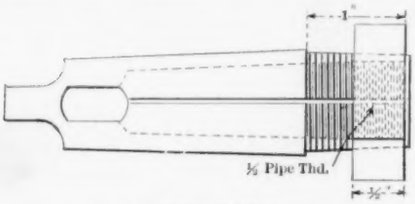
Designing a Boring Mill.

In common, perhaps, with a good many of your readers, I am rather at a loss to know whether the article at page 303 on Designing a Boring Mill is an elaborate piece of sarcasm or a *bona fide* development of the writer's views on the subject of machine design; in other words, whether it is a gigantic "take-off" on the methods of ignorance and conceit, or an even more gigantic exhibition of the working of those mental qualities. It is possible to detect stray gleams of humor and of intelligence in about equal numbers, so there seems to be some foundation for either hypothesis. If the article is to be taken at its face value, it is enough to say that the methods advocated tend to enrich the scrap-heap rather than the stockholders. L. C. L.

Lehigh University.

A Drill Socket.

Enclosed is a sketch of a split collet which will drive drills after the tang is broken off; the arrangement also saves the collets, especially in structural work, when drilling through the flanges of beams and channels. The collet is the



A DRILL SOCKET.

Morse standard turned and threaded at the end to pipe standard, an ordinary hexagon nut being tapped out to suit.

G. I. B.

The growth of amusement enterprises is shown by the projected Friede "globe tower" which is expected to be in operation at Coney Island during the season of 1907 and which is proclaimed as the largest steel structure in the world. The structure is to be a skeleton steel globe of 300 feet diameter supported by lattice columns and with an observatory at the top, the extreme hight to the top of the flag pole being 700 feet. The structure is to contain all sorts of amusements, among them being a hippodrome at an elevation of 250 feet from the ground.

A beginning has been made in the carrying of mail through the Chicago freight subways, the first train load of mail bags having gone through on Feb. 24.

The Electrical Works of Messrs. Schneider at Champagne-sur-Seine.

BY EMILIE GUARINI.

In 1903, Messrs. Schneider & Co. transferred their works from Creusot (where they were no longer of sufficient size) to Champagne-sur-Seine, department of Seine-et-Marne, France.

The works are shown in Fig. 1. They cover an area of 50 acres, and comprise seven main buildings covering the different branches of manufacture. In the center is a large building having a central nave 82 feet in width, and two aisles; it covers a space 560 feet in length by 165 in width. At each side of this main edifice there is a group of three buildings

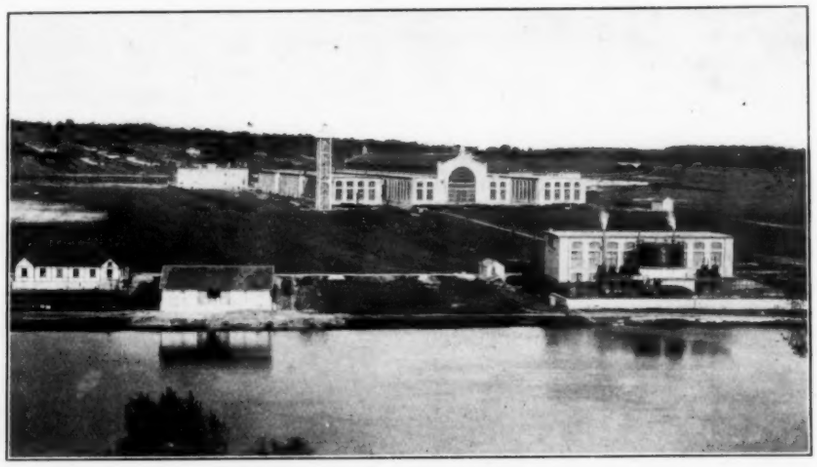


FIG. 1. THE SCHNEIDER ELECTRICAL WORKS.

each 165 feet long by 82 wide. There is also a building for the business offices, not far from which is a timekeeper's house, the director's residence and the dwellings of heads of departments; and close to the Seine there is a power and lighting station.

This central station is provided with three gas engines of the Delamarre-Debouteville and Schneider type, each composed of two single-action cylinders mounted in tandem. These obtain their gas from a battery of six Buire-Lencauchez generators equipped with purifying apparatus. Two double-acting pumps with an output of 20,000 gallons per hour supply water from a well for the producers and for cooling the pistons. A large tank also receives its water from these pumps and supplies it to different parts of the works and to the workmen's houses.

The generators (175 kw.) are of the multi-polar type, and the current is distributed by means of three wires to the two workshops, so as to serve for lighting and power. The generators also charge a storage battery for reserve and regulation purposes. The arc lamps for lighting the workshops, yards, etc., are arranged in series for current of from 10 to 12 amperes, at 220 volts, and incandescent lamps for the shops are also fed under a pressure of 220 volts. Current at 440 volts is used for motors above 3 kw., and for those of the traveling cranes in general; the smaller motors are operated under 220 volts. The current is transmitted over aluminum cable with a purity coefficient of 0.995, and with a conducting power of 0.575 to 0.6 that of copper.

Two connections are made by bringing the ends of the cable together, heating in a metal mold lined with fireclay, by means of a smith's forge, and pouring the melted aluminum into the mold. The joint is subsequently finished by filing. The weight of the lines is thus reduced by half, and the price of the cables remains below that of the same wires in copper. These cables are each formed of 37 wires of 2.25 mm. diameter.

A branch of the Paris-Corbeil-Morte reau line serves these works, while other branch lines connect them to a quay built on the bank of the Seine. The offices are in a two-story building, where there are also two drawing offices, 52x33 feet, with the northern facade completely covered in with glass. The central portion of this building has a sloping roof where a glass-roofed attic is used for making prints, electric light being used when sunlight is lacking. The annexed buildings are at a distance of 50 feet from the main edifice and 33 feet apart. The first annex to the northwest is used for the manufacture of windings and coils. It is provided with portable stoves which are heated by hot air to 150 degrees and which serve for drying the armatures and windings. The work is handled by means of two traveling cranes, one of 15 and the other of 5 tons capacity. The second building of the same group is divided into two parts, and comprises in the one division such equipment as shears, forges, annealing furnaces, plant for tempering tools and the like. The other contains machine

tools for the manufacture and finishing of special machinery. The third building, which is served by a five-ton traveling crane, contains some small machine tools; this building is intended for the manufacture of switchboards, etc., and a special department is set apart for nickeling and burnishing work.

Of the three buildings to the south, the first, which is divided into two rooms, is devoted to the preparation of micanite and to the storage of stock, which from here is distributed as required to storerooms in the different buildings. The second building contains the timber store, the carpenter and joiner's shop, the model department, and the model storeroom. The third building serves as a storehouse for the finished machines which are also painted here, packed and shipped. This building is fitted with a traveling crane of 25 tons capacity.

In the central bay of the large building Fig. 2, large dynamos are assembled and tested; of the two lateral bays one is reserved for the cutting and trimming of plates, and the other for the mounting and adjustment of transformers and small units. In this latter portion is also installed the lathe department, and in the other bay there are drills, milling machines, and other small and medium-sized tools. The nave contains the large machine tools, and is equipped with three traveling cranes of 75-foot span and 25 tons capacity, metal pillars supporting the rails and tracks. Each of the two lateral bays is served by two 5-ton cranes.

Castings are tested in a room at one end of the main section. The floor of the testing-room is composed of cemented tiles provided with cavities fitted with fluted iron rails to admit of the fixing down of the parts to be tested. Tests under high tension, also all tests of copper and iron sheets, are made in special testing-rooms, arranged like the clerks' offices, at one end of one of the wings of the central building.

The machining of the large pieces of machinery is effected in the main work shop by the aid of floor plates and portable tools. The plates have a superficial area of 1000 square feet, and have current up-takes fitted at different points.

In various workshops the tools absorbing power exceeding 0.75 kw., are driven by individual motors; the others are group-driven from shafts 16 feet in length.

The various buildings, which are all well lighted, are built of local limestone, and the sloping roofs, except in the case of the central portion of the main building, are formed of stout rafters supporting a covering of cement, sand and fine gravel; a very light non-inflammable lining of plaster and lath is fixed to the rafters. The main section of the central building is roofed in with tiles in the ordinary manner.

FIG. 2. VIEW IN MAIN BUILDING.

Boiler Bursts Under Hydraulic Test.

A new boiler, built in Austria of basic steel, burst recently while undergoing the usual hydraulic test, resulting in the death of a man who was at the time marking some leaky rivets. The boiler was of the horizontal return tubular type, with a steam dome. The plates were of steel supplied by a well known German firm. The boiler was about 6 feet diameter by 12 feet long. The dome which failed was about 3 feet diameter by 3 feet high, its shell being about ½ inch thick. The fracture occurred in the solid part of the cylindrical shell and did not extend to the edges.

The boiler was built for a pressure of about 150 lbs. A primary test, with water, had been made at 75 lb. pressure. A second test was made some days later. When the hydraulic pressure reached 202 lb., the dome fractured without warning. In England basic steel is regarded with considerable mistrust, owing to frequent failures of plates made from phosphoric pig. For this reason acid open hearth steel is usually insisted on by engineers and inspectors in that country.

Test pieces were taken from the plate which fractured and these showed a tenacity of nearly 60,000 lb. per square inch, and an elongation of nearly 25 per cent. in 8 inches; yet this boiler burst at only 52 pounds over its working pressure.

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Untaxed Denaturized Alcohol.

We have received a copy of the report of the hearings of the Committee on Ways and Means of the House of Representatives on the proposed removal of excise duties from alcohol for industrial purposes, and if any reader of this paper has doubts regarding the importance of the subject such doubts will be removed by a perusal of this pamphlet.

The hearings were opened by the Secretary of Agriculture and the Commissioner of Internal Revenue, the former of whom pointed out the importance of the subject to the agricultural interests of the country, not only in supplying a market for what are now largely waste products but in stopping the rise in price of fuel for internal combustion engines, which are finding large use on the farms of the country.

The Commissioner of Internal Revenue devoted his attention to the probable effect of the proposed law on the revenues, to the phraseology of the bill, which he did not regard as sufficiently explicit, and to the danger of fraud, which he did not regard as serious.

Following these Government officers representatives were heard from the following industries and organizations: The Patrons of Industry, the piano manufacturers, the American Chemical Society, the Society of Chemical Industry, the Philadelphia Trades League, the Detroit Chamber of Commerce, the Chardonnet Artificial Silk Company, the Associated Chair Manufacturers of New York, the Fur Hat Manufacturers' Association, the Hat Manufacturers' Association, the American Hardware Company, the Brotherhood of Painters, Decorators and Paper Hangers, the American Confederation of Labor, the Otto Gas Engine Works, the Welsbach Light Company, the International Harvester Company and the General Electric Company.

To all of these industries the subject is of importance and to some of them of very large importance. The leading facts brought out by the hearings are the far reaching industrial use and importance of alcohol, the manner in which the present tax is a burden on industries and the large development of industry which only awaits the removal of the tax. Moreover, these are not matters of inference, the removal of the tax in several foreign countries having been followed by such a development as is predicted here, in some cases by the actual removal of industries from our own territory and in many others by the development of industries abroad at our own expense and for the supplying of our own needs.

Belt Dressing and Free Watches.

The works manager of a prominent manufacturing company sends us a letter received by him from the Buffalo Specialty Company, of Buffalo, New York, which company, it seems, is exploiting a certain belt dressing, and in doing this it announces that it proposes to do no newspaper advertising; but that the money that would ordinarily be spent in that way is by this company invested in fine gold watches, which are offered "free gratis for nothing" to those who will simply order a quantity of belt dressing amounting to $21 and give it a trial.

Of course we cannot look into the minds of those who administer the affairs of the Buffalo Specialty Company and see what they are thinking, or what they expect; but the obvious effect of their proposition will be to tempt a person who controls the matter of supplies to order some of their belt dressing in order to get the watch, and that being the case, it is also obvious that those factory managers, purchasing agents, etc., who wish to avoid the appearance of evil will have nothing to do with such a scheme. In fact, the gentleman sending us the proposition expresses himself to that effect in his letter accompanying it. He is a trained and educated engineer, with his self-respect to maintain. When he is buying belt dressing for use in the factory over which he presides, he will inevitably take some pains to ascertain which is the best belt dressing, and which will be most advantageous for him to buy, considering the interests of the factory only. When he wants a watch he will go to the people who deal in watches and endeavor to get the best possible value for his money. In the meantime, those factory proprietors who are asked to O. K. bills for Electric belt dressing may well ask their superintendent, or their purchasing agent, not how the belt dressing is working, but how the watch is running.

Electrical Music.

According to the *Electrical World and Engineer* an entirely new application of electricity has been developed by Doctor Cahill, of Holyoke, Mass., namely the generation and distribution of music.

The new apparatus is in no sense a telephone or phonograph, although the receiver is somewhat similar to a telephone receiver. The original apparatus makes no music but instead produces a series of electrical waves which are translated into music by the receivers, of which there may be an indefinite number and in the absence of which even the performer would hear nothing.

The apparatus is extremely complicated, involving primarily a battery of alternators of different frequencies which answer in a general way to the strings of a piano or the pipes of an organ. A key-board similar to that of an organ operates switches by which the several alternators are brought into action and made to send currents to the line, the receivers translating these electrical vibrations into sounds. By a series of expression

devices and inductoriums or tone mixers, harmonies are introduced, producing effects similar to various musical instruments, together with others which are produced by no existing instrument.

According to our contemporary a central station plant will soon be installed in this city, from which music will be distributed to hotels, restaurants, theaters, concert halls, etc., the plant having a capacity for supplying four or five thousand outlets.

The idea may succeed commercially but we do not believe that the music by means of which one human being conveys ideas and emotions directly to others will ever be superseded.

New Publications.

"The Seven Follies of Science." By John Phin. 178 5½x7½-inch pages, with 34 illustrations. The D. Van Nostrand Company, New York. Price $1.25.

Most of us have heard of the seven follies of science as we have heard of the seven wonders of the world, but few could give a correct list of either. According to Mr. Phin the seven follies are the squaring of the circle, the duplication of the cube, the trisection of an angle, perpetual motion, the transmutation of metals, the fixation of mercury and the elixir of life. These follies are discussed in a very interesting manner, the squaring of the circle and perpetual motion being given the most space. In connection with the former an account of the working out of the ratio between the diameter and circumference of a circle is given, beginning with the first value to be worked out scientifically—that of Archimedes, who found it to be between 3.1408 and 3.1428—and coming down to the determination of Mr. Shanks, who in 1873 carried the result to 707 places of decimals. In the chapter on perpetual motion illustrations of many of the devices which have been seriously offered as solutions of the supposed problem are given, as well as some of the frauds. The book also contains an appendix entitled A Small Budget of Paradoxes, Illusions and Marvels, wherein are given a number of optical and other illusions. The book contains much of interest to those who enjoy accounts of the vagaries of the mind and senses.

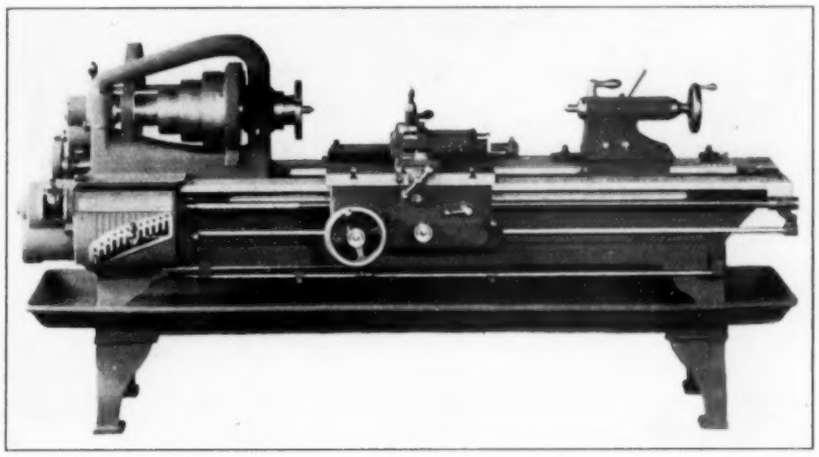
"Link Motions, Valves and Valve Setting." By Fred H. Colvin. 82 4x6-inch figures, with 43 illustrations. The Derry-Collard Co., New York. The Locomotive Publishing Company, London. Price, 50 cents.

This little manual gives a very clear and concise account of the action of the slide valve and link motion, together with the operations of setting them in the shops. Valves of different types, including plain and balanced slide valves and piston valves, are shown, as well as various valve gears other than the Stevenson link motion.

New Tools and Machine Shop Appliances.

ENGINE LATHE WITH TIE-BAR REINFORCEMENT FOR HEAD.

This lathe is the regular Hendey-Norton tool as built by the Hendey Machine Company, of Torrington, Conn., except that the head is now provided with a tie-bar reinforcement which increases its rigidity and gives added support to the spindle when under heavy duty. The reinforcement is of especial advantage where there is considerable end pressure, as in heavy turning and chucking, as it prevents any backward deflection of the front housing which might tend to bind the spindle and cause it to run hard. The new lathe head retains the annular form of housings and bearings with taper journals on the spindle and with the self-oiling and self-adjusting features as regularly applied by this company to their lathes. Although shown with a 4-step cone, all sizes of these lathes, from 14-inch to 24-inch inclusive, may be fitted with a 3-step cone in the headstock, adapting them particularly for high-speed steel service, as one-third more belt surface is then obtained for each step. With the 3-step cone 12 speeds are obtained for the spindle, as the countershaft has two rates of speed, giving six speeds direct and six through the back gears. The lathe is furnished with or without pan, as required.

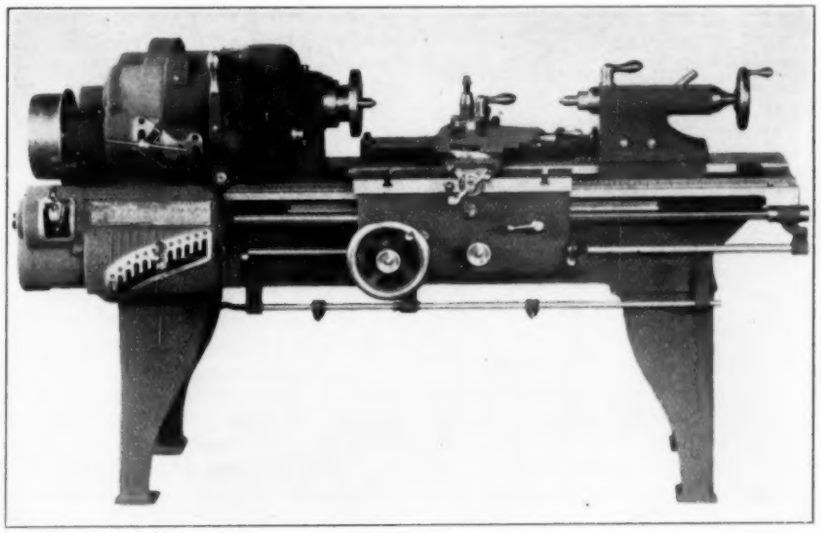


LATHE WITH TIE-BAR REINFORCEMENT FOR HEADSTOCK.

ENGINE LATHE WITH ALL-GEARED HEAD.

The half-tone shows the Hendey-Norton lathe as equipped with an all-geared headstock, which provides for eight changes of speed in the gear box, the changes being obtained by means of the two levers at the front of the casing.

The construction of the main spindle and its bearings remains identical with that of the Hendey-Norton regular pattern lathe head, the bearings being annular in form, with a cylindrical fit in the annular housings, the spindle journals being taper and fitted with ring oilers running in oil reservoirs and the adjustments of front and rear journals in the bearings being independent of each other. The back-gear shaft and the driving shaft also are fitted

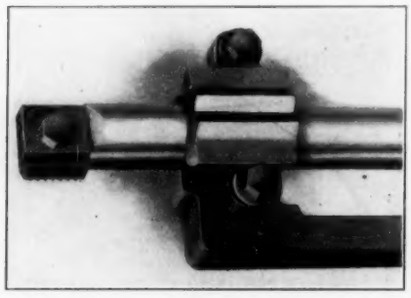


LATHE WITH ALL-GEARED HEAD.

with ring oilers. Of the eight changes of speed for the spindle to be had with the driving shaft running at a constant speed, four are obtained direct and four through back gears. The four direct speeds are obtained with a geared cone on the spindle driven through transfer gears in a rocker. The back gears are permanently meshed with their relative gears, which run free on the spindle. The change from direct to back-geared drive is controlled by a clutch working between the large gear of the cone and the face gear. This clutch is actuated by the lever shown toward the front end of the head. All gearing is of steel, except the large face gear and large back gear, so that changes of speed and throwing in or out of the clutch in either direction may safely be accomplished without stopping the driving shaft, except to slow down for the highest speed change. When the lathe is driven from a two-speed countershaft the speed ratio should be 1.28 to 1 in order to obtain spindle speeds ranging in geometrical progression. The gear casing is so designed that a motor may be attached when required. The lathe shown is the 16-inch size, with 6-foot bed; with countershaft speeds of 325 and 416 revolutions per minute the spindle speeds of this lathe range from 10 to 400 turns per minute.

LATHE-TOOL HOLDER.

The tool holder shown in the half-tone is designed to be clamped in a lathe tool post, and to hold various tools, as boring bars, drills, threading tools, etc. In the jaw, which is in one piece with the shank,



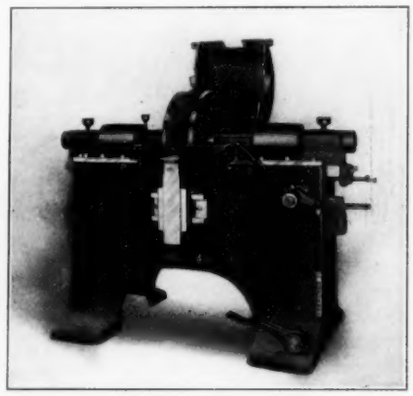
LATHE-TOOL HOLDER.

is formed a V-groove, and the cap has a corresponding V-groove, and also a smaller groove on its upper surface as seen in the picture, so that the cap can be reversed for clamping tools of smaller size. The clamping bolts pass through slots in the ears of the cap, so that it is only necessary to slack up on the bolts in order to remove the cap. With the cap reversed from the position shown, implements from 5/16 inch to 1¼ inches may be secured, and in the position illustrated, it will hold from 1¼-inch to 2-inch shanks. The shanks of the tools can be either circular or polygonal. The holder was photographed holding an internal threading tool of the type illustrated at page 751, Vol. 28, Part 2. It is claimed for this tool holder that it facilitates the changing of tools. It is made by P. J. Kelly, 514 Meadow street, Elizabeth, N. J.

A DOUBLE-HEAD DISK GRINDER.

The illustration shows a double-head disk grinder equipped with wheels 20 inches diameter by ¾ inch thick.

The wheels are moved to and from each other by hand lever or by foot lever, or by both. Both levers can be clamped in any position required. The hand-lever shaft



A DOUBLE-HEAD DISK GRINDER.

carries a gear which engages at the top with a rack attached to the right-hand head, and at the bottom with a rack which is fastened to a bar hinged to the left-hand head. Working the lever moves the heads to and from each other. The lower rack can be dropped out of mesh, the left-hand head locked in any position required, and only the right-hand head moved to the work.

It is sometimes desirable to move both heads, as is the case with work in which the opposite sides are not of equal area, or when it is necessary to grind more off from one side than the other. In the latter case the work is secured in a holder and the rest so adjusted that the right amount can be ground off either side independently of the other. The wheels can be moved apart by a spring, which is attached to an adjustable lever. This enables the operator to use the foot lever only and devote both hands to the work.

There is a back stop to prevent the wheels from moving back too far. The screw stop regulates the forward movement of the wheels. The foot lever is connected with the rack-gear shaft by sprockets and chain. The chain is adjustable to take up the stretch.

The wheels are closely covered with a cast-iron hood, the top half of which is hinged (shown thrown back in the illustration) and locked at the front with hinged bolts and thumb nuts. The opening at the front, as shown, is 8x12 inches. The machine is provided with adjustable sheet-metal shields, which are attached to the hood with thumb screws. With these the opening can be reduced to any size required. At the back of the machine there is a flanged opening from the bottom of the gap in the bed for connecting the exhaust pipe.

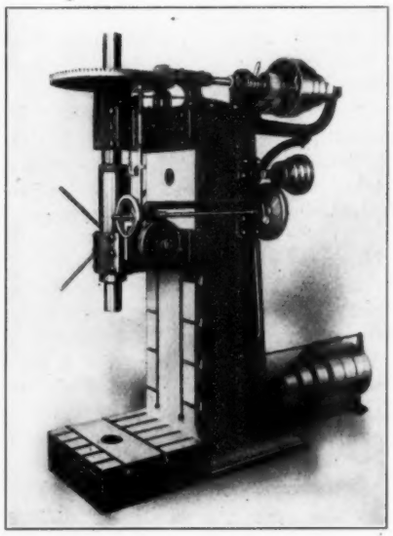
The levers are of malleable iron, the racks, gears and sprockets are steel. The machine is equipped with oiling devices, setting-up press, countershaft, wrenches, etc. The spindles are 2 inches diameter. The wheel collars 5x1¼ inches, the spindle pulleys 7 inches diameter by 8½ inches face. The distance between wheels varies from 0 to 14 inches. This machine is made by the Gardiner Machine Company, Beloit, Wisconsin.

A MACHINE FOR PUNCHING, SHEARING AND CUTTING BARS.

This machine is built for the use of sheet-iron workers. The frame of the machine is made of armor plate, the rest of the parts are drop forgings and crucible steel, the base of the machine being the only part made of gray iron. A special feature of these shears is that they will shear any length without binding or crimping. They are built in three sizes, punching ¼x¼ inch, ⅜x⅜ inch, ½x½ inch; shearing 12, 10 and 8 gage iron; cutting ½-inch, ⅝-inch and ¾-inch round iron; or flat iron ¼x1¼, 5/16x2, and ⅜x 2½ inches, respectively. They are built by the Buffalo Forge Company, Buffalo, New York.

A VERTICAL BORING AND DRILLING MACHINE.

The illustration shows a machine, specially designed for boring engine cylinders,



A VERTICAL BORING AND DRILLING MACHINE.

which is adapted for heavy, rapid and accurate work.

The spindle is of crucible steel 3 7/16 inches diameter with a No. 5 Morse taper hole in the end. It has both hand and automatic feeds with a traverse of 14½ inches, which may be automatically stopped at any desired point. The spindle is counterbalanced.

The bevel gears at the top have a ratio of 6 to 1 and the machine is also back-geared 4 to 1, this giving a ratio of 24 to 1.

The base is equipped with stationary and rotating sleeves in which the end of the boring bar may be supported. The

rotating sleeve is provided with a cap to prevent the borings from entering its bearings. Both the base and the face of the column are planed and provided with T-slots for securing the work. Greatest distance from the spindle to the base is 28½ inches; distance from the face of the column to the center of the spindle, 13 inches; size of table, 22x24 inches; floor space necessary, 24x32 inches; total hight, 90 inches.

This machine is built by the Hoefer Manufacturing Company, Freeport, Ill.

A DOWN-DRAFT FORGE FOR RAILROAD WORK.

This forge was designed for the heaviest and largest work encountered in railroad blacksmith shops, necessitating a free overhead space for placing work in and removing it from the fire.

There are five tuyeres, spaced about a foot apart from center to center, each withe a 4-inch blast pipe and controlled by a separate blast valve and lever so that a very heavy fire and, if necessary, a welding heat 5 feet long may be maintained. The air is supplied from a single main of large size; the hood is made so as to swivel. In this way there is no obstruction to the handling of heavy work by cranes. The forge body is made of boiler plate and the hoods are of the same material, but of lighter gage and are very easily swung around.

The exhaust system consists of underground brick ducts connected to exhaust fans for removing smoke and gases.

These forges are made by the Buffalo Forge Company, Buffalo, New York.

Convention of the National Metal Trades Association.

The National Metal Trades Association held its eighth annual convention at the Hollenden Hotel, Cleveland, Ohio, March 21 and 22. The membership of the association was well represented and a gratifying feature of the attendance was the representation of all sections of the country.

On Monday and Tuesday preceding the convention the administrative council of the association was in session and transacted a large amount of detail work, and the opening of the convention found these matters of routine entirely disposed of.

A pleasant feature of this pre-convention work was the dinner tendered to the administrative council by Howard C. Eels, of the Bucyrus Company, at the Union Club of Cleveland. At this dinner 23 of the 25 members of the council were present. H. N. Covell, former president, officiated as toast master and a most delightful evening was enjoyed by all.

The convention proper convened Wednesday morning in the large assembly-room of the Hollenden and was opened by President J. W. Gardner, of the Gardner Governor Company, Quincy, Ill. In the absence of Mayor Tom L. Johnson, of Cleveland, the delegates were welcomed to the city by Commissioner H. L. Cooley, of the City Council.

Reports of the various committees were heard, which showed the affairs of the association to be in a gratifying condition. F. K. Copeland, treasurer, reported the finances of the association in a better condition than ever before, with a strong reserve fund and an ample balance in the fund for current expenses. The report of Secretary Wuest also included the report of the commissioner, as Mr. Eagan has had to relinquish the duties of his position because of continued ill health. In the course of his report Secretary Wuest said:

"During the past year the work of the association has been almost exclusively confined to the preventing of rather than that of combating strikes, and I feel quite confident that the employees of many of our members appreciate that the National Metal Trades Association is operated as much for their benefit as it is for that of their employers. In nearly every case we handled, we demonstrated to the employees that our members will stand by and aid them in securing their rights.

"In a number of cases demands were presented, but thanks to the advice given by your officers and the special contract operatives and men which were supplied, the threatened difficulty was forestalled. In the majority of these cases the personal attention of your commissioner and secretary was required. Up to this time no active strike trouble has developed in any of these cases. Your acting commissioner feels warranted, however, in making the statement that in many of them active trouble would have ensued had it not been for the fact of their membership in the association.

"We have accomplished all of this work without any special assessment and it certainly must afford the members pleasure to know that the association is in a financial condition to effectively defend any trouble which may ensue."

The report disclosed a remarkable growth in membership. The membership in good standing March 1, 1905, was 358, March 1, 1906, it was 523, a gain of 165, or 46 per cent. Applications pending were reported from the following: Rider-Ericsson Engine Company, New York; Hamler Boiler and Tank Works, Chicago; George L. McGregor, Chicago; George E. Corbett & Co., Chicago; Page Boiler Company, Chicago; Sullivan Boiler and Tank Works, Chicago; P. McGarry & Son, Chicago; M. E. Herber Heater Company, Chicago; Charles Hafner, Chicago; E. Van Winkle Gin and Machine Works, Atlanta, Ga.; Glover Machine Works, Marietta, Ga.; Lombard Iron Works, Augusta, Ga.; DeLoach Mill Manufacturing Company, Atlanta, Ga.; Stevens Machine Company, Atlanta, Ga.; Fulton Foundry and Machine Company, Atlanta, Ga.; Southern Iron and Equipment Company, Atlanta, Ga.; Mallary-Taylor Iron Works, Macon, Ga.; and Bartlett & Snow Company, Cleveland.

At the call for resolutions during the morning session the following resolutions were adopted:

Whereas, the influence of the press is at all times regarded as being paramount and a most important factor in influencing and molding public opinion.

Therefore, be it resolved, that this association desires to place itself on record as appreciating in the fullest degree the stand taken by the Hill Publishing Company, of New York, publishers of the AMERICAN MACHINIST, *Power* and *The Engineering and Mining Journal*, and the Penton Publishing Company, of Cleveland, publishers of the *Iron Trade Review* and *The Foundry*, and the position they have taken in the recent demand of the printers in their employ for an eight-hour day and a closed union shop: and

Resolved, that the secretary of this association be instructed to communicate with the above-mentioned companies and express the approbation of this association for the patriotic position which they have so successfully maintained.

A most enjoyable feature of the convention was the banquet tendered to the visiting members and their friends by the manufacturers of the city of Cleveland. This was held on Wednesday evening in the banquet room of the Hollenden Hotel and was most elaborate. Speeches and talks were given by several of the city officials of Cleveland and by members of the association. Impromptu music was furnished by various musically inclined members and at an adjourned session, later in the evening, individual stunts by certain amateur entertainers were heartily appreciated.

On Thursday morning papers were read on a variety of subjects of interest to the association and were freely discussed by those interested; and a further discussion of a plan of closer co-operation with the National Founders Association was held.

At the annual election of officers for the ensuing year the following were elected: President, W. D. Sayle, Cleveland Punch and Shear Works, Cleveland, Ohio; first vice-president, M. H. Barker, American Tool and Machine Company, Boston, Mass.; second vice-president, F. K. Copeland, Sullivan Machinery Company, Chicago, Ill.; treasurer, Wm. Lodge, Lodge & Shipley Machine Tool Company, Cincinnati, Ohio; councilors, H. P. Eels, Bucyrus Company, S. Milwaukee, Wis.; J. Kirby, Jr., Dayton Manufacturing Company, Dayton, Ohio; W. M. Taylor, Chandler & Taylor Company, Indianapolis, Ind.; J. H. Schwacke, William Sellers & Co., Philadelphia, Pa.

The convention adjourned Thursday

afternoon with the members enthusiastic over the entirely profitable and enjoyable occasion.

Among those present were: F. A. Geier, Cincinnati Milling Machine Company, Cincinnati, Ohio; P. B. Kendig, Seneca Falls Manufacturing Company, Seneca Falls, N. Y.; C. E. Hildreth, Whitcomb-Blaisdell Machine Tool Company, Worcester, Mass.; G. K. Garvin, The Garvin Machine Company, New York; Frank L. Coes, Coes Wrench Company, Worcester, Mass.; G. F. Stewart, Bradford Machine Tool Company, Cincinnati, Ohio; Wm. Lodge, Lodge & Shipley Machine Tool Company, Cincinnati, Ohio; E. E. Bartlett, Boston, Mass.; H. F. Arnold, American Tool & Machine Company, Boston, Mass.; A. H. Bullard, Bullard Machine Tool Company, Bridgeport, Conn.; A. M. Powell, Woodward & Powell Company, Worcester. Mass.; F. H. Stillman, The Watson-Stillman Company, New York; A. E. Newton, Prentice Brothers Company, Worcester, Mass.; R. K. LeBlond, LeBlond Manufacturing Company, Cleveland, Ohio; P. G. March, Cincinnati Shaper Company, Cincinnati, Ohio; Benj. Sebastian, Sebastian Lathe Company, Cincinnati, Ohio; Isador Rau, Cincinnati Electric Tool Company, Cincinnati, Ohio; H. C. Hoefinghoff, Bickford Drill and Tool Company, Cincinnati, Ohio; F. M. Cresson, Geo. V. Cresson Company, Philadelphia, Pa.; J. C. Hobart, Triumph Electric Company, Cincinnati, Ohio; E. C. Henn and E. C. Woolgar, National Acme Manufacturing Company, Cleveland, Ohio; C. E. Whitney, The Whitney Manufacturing Company, Hartford, Conn.; D. Hunt, Warner & Swasey. Cleveland, Ohio; B. B. Quillen, Cincinnati Planer Company, Cincinnati, Ohio; G. E. Merryweather, Motch & Merryweather Machine Company, Cleveland, Ohio.

Dreses Machine Tool Works Burned.

The friends of Henry Dreses, of Cincinnati, will regret to learn that a disastrous fire destroyed the works of the Dreses Machine Tool Company on March 16. New quarters better suited to the purpose have been secured and the work will be delayed only about two weeks.

A boiler inspector for the Department of Public Works of New York is to be appointed at a salary of $3,000. Application forms are to be obtained by addressing Charles S. Fowler, Chief Examiner, Albany, N. Y.

Personal.

P. S. Souders, formerly in charge of the tool room of the Burroughs Adding Machine Company, has accepted a similar position with the Barber-Colman Company, of Rockford, Ill.

Gorham C. Parker, formerly manager of the Superior Tap Company, Springfield, Vt., and later representing the Tool Steel Wire Company, in New England, has resigned the latter position to become sales manager of the Jacobs Chuck Company, Hartford, Conn.

Obituary.

Mark Dean Knowlton, president of the M. D. Knowlton Company, manufacturers of paper-box machinery, Rochester, N. Y., died at Boston, Mass., March 2.

William H. Campbell, an inventor, died of heart disease recently at his home in Flatbush, L. I., aged 60 years. Mr. Campbell served twelve years in the United States Navy, afterward establishing a large business through his inventions. He originated among other ideas the duplex system of manufacturing railway tickets.

Herman J. Eisen, for many years model maker for the New England Watch Company, Waterbury, Conn., and originator of four-score patents on watches, watch-making machinery and astronomical instruments, died March 17, aged 80 years. Mr. Eisen was born in Düsseldorf, Germany, and came to this country in the early '50s. He worked for some years in Geneva, Switzerland, on astronomical clocks, and before coming here traveled extensively through Europe, during this period learning to speak French, Italian, English, Hebrew and other languages. He served four years in the Union army during the Civil war and directly after the close of the war took up watch making and model work, and received patent after patent upon his inventions. Prior to locating in Waterbury he had worked with many clock and watch establishments in Connecticut and other Eestern States.

Business Items.

Pawling & Harnischfeger, Milwaukee, Wis., builders of electric traveling cranes and hoists have opened an office at 45 Broadway, New York, N. Y. Wm. F. Brewster has been placed in charge.

The Northern Engineering Works, Detroit, Mich., have recently supplied to the foundry of the Holland Radiator Co., Bremen, Ind., about 100 feet of overhead trolley track with hangers, curves, switches and trolleys comprising a modern overhead foundry distributing system.

The Gardner Engineering Company has been incorporated with the following officers: J. G. Lipper, president, W. B. Harsel, vice-president; B. C. Woodford, secretary and treasurer. The main office of the company will continue to be at 136 Liberty street, New York, N. Y.

In considering the application of electric motor drive many power users defer the use of electricity because of the trouble which seems inevitable in changing over to electric motor drive. The electrical equipment produced by the Northern Electrical Manufacturing Company, Madison, Wis., U. S. A., is they claim characterized by ease of application and convenience of arrangement, location, and operation. For certain classes of work a special type of variable speed motor, described in Bulletin 45 has been developed. Northern multi-speed motors, as they are termed, are especially designed for applica tion to engine lathes.

Manufacturers.

The Page Belting Company, Concord, N. H., will enlarge its plant.

The California Iron Company, San Diego, Cal., will enlarge its plant.

The Globe-Wernicke Company will increase its plant at Norwood, Ohio.

The Oregon (Wis.) Self Feeder Company will move to Watertown, S. D.

The Berlin (Conn.) Construction Company will build an addition to its plant.

The New York Central Railroad will build a cold storage plant at West Albany.

Huther Bros., Rochester, N. Y., saw manufacturers, wil put up a new factory.

The Michigan Paper Company, Plainwell, Mich., is constructing a $200,000 plant.

The Standard Spoke and Nipple Company, Torrington, Conn., will erect a new plant.

The A. M. Forbes Hardware Company, Vancouver, B. C., will erect a new factory.

The Washburn Company, Minneapolis, Minn., will enlarge its steel casting works.

An addition will be built to the plant of the Carr Foundry Company, Baltimore, Md.

The Crown Cork and Seal Company will erect a new factory at Highlandtown, Md.

The Wright Wire Company is considering the enlargement of its plant at Palmer, Mass.

The Griffin Wheel Company Chicago, Ill. will erect a new plant to cost about $200,000.

The Union Switch Signal Company is building an addition to its plant in Swissdale, Pa.

The Vulcan Iron Works, Wilkesbarre, Pa., will build an addition to its locomotive plant.

The Mahony Heating, Ventilating and Blower Company, Troy, N. Y., will erect a plant.

Fred Twining, Twining, Mich., will erect a machine shop and implement and carriage shops.

The Illinois Warehouse Company, Peoria, Ill., will erect a $200,000 cold storage warehouse.

The plant of the Oscar Lear Automobile Company, Columbus, Ohio, will be moved to Zanesville.

The Northern Ohio Metal Refining Company, Norwalk, Ohio, is seeking a site in Toledo, Ohio.

Plans have been completed for a new wood-work factory for Welchlin Bros., Fairmont, Minn.

The Hoosier Manufacturing Company, New Castle, Ind., maker of kitchen cabinets, will double its plant.

Sargent & Company, New Haven, Conn., is going to put up a five-story addition to its lock department.

Seymour's White Laundry, 412 Nebraska St., Sioux City, Iowa, is in the market for oil burning outfit.

Fire damaged the plant of the St. Joseph (Md.) Pump and Manufacturing Company to an extent of $10,000.

The Waterman Car Wheel and Foundry Company, Houston, Texas, a new company is now putting up a plant.

The crushing plant of the Blue Limestone Company, Minneapolis, Minn., was damaged by fire to an extent of $10,000.

The Goldschmidt Thermit Company, 43 Exchange Place, New York, will build a $10,000 factory in Jersey City.

The Timken Roller Bearing Axle Company, Canton, Ohio, will enlarge its plant expending over $50,000 in improvements.

Burdick & Son, manufacturers of stove specialties, dies, etc., Albany, N. Y., will add a four-story building to their plant.

F. G. Hobart, Beloit, Wis. Circular illustrating and describing a parallel attachment for drawing boards and tables.

The Martin (Ga.) Gin Company will erect a new building equipped with the most improved machinery, operating four gins.

The Chicago & Northwestern Railroad Company will put up new shops at Janesville, Wis., at a cost of about $500,000.

Plans are now being made and contracts given out for a large foundry at the works of the General Electric Company in Lynn, Mass.

The New York, New Haven & Hartford Railroad has plans prepared for a new machine, erecting and boiler shop at Readville, Mass.

The De Sota Foundry and Machine Company, Ltd., has been incorporated at Mansfield, La. Capital $30,000. F. Kavanaugh, president.

The Sitterding-Carneal-Davis Company, Richmond, Va., will expend $50,000 in equipping a factory for the manufacture of wire screens.

The Omaha (Neb.) Ice and Cold Storage Company will double the capacity of its artificial ice plant, spending about $50,000 on an addition.

A blacksmith shop, to be equipped with modern machinery, is being constructed at the plant of the Western Block Co., East Lockport, N. Y.

The John A. Frye Shoe Company is preparing to establish a pasteboard box and carton making department at its factory in Marlboro, Mass.

Improvements to cost $150,000 will be made at the power station and car-house of the New York City Street Railway Company on Amsterdam Avenue.

The Southern Skewer Company is being organized at Memphis, Tenn. Capital $30,000. O. G. Gardner, of Jackson, Tenn., is one of the incorporators.

W. J. Swanger, S. D. McClain, J. Wood Wilson of Marion, Ind., and others, are organizing a $100,000 stock company to manufacture stoves and ranges.

Plans have been completed for a new tailing plant for the United States Reduction and Refining Company at Colorado City, Colo., to cost about $200,000.

A company is being formed in Rockford, Ill. to manufacture artifical ice on a large scale. Edward F. Pendergast, a former alderman, is promoting the concern.

The Huntington Beach (Cal.) Canning, Pickling and Produce Company, has been organized with a capital of $100,000. M. F. Frie, W. T. Newland, etc., directors.

The Rumsey Manufacturing Company, building gas and gasolene engines, whose plant at Ripley, N. Y., was burned a short time ago, will rebuild in Friendship, N. Y.

The Downie-Wright Company, of York, Neb. will move to Rapid City, S. D., where a modern plant for the manufacture of its mining machinery and milling machines will be put up.

William Farr, C. H. Hopkins, David Kimberly, and others of Asheville, N. C., are forming a company for the purpose of establishing a foundry and machine shops in Asheville.

The Albany (N. Y.) Refrigerating and Warehouse Company has been organized with a capital of $22,000. E. P. Williams, commission merchant, of Albany, is chief promoter.

The Pioneer Cotton Mills has been incorporated by Guthrie, Okla. people. A $150,000 mill will be erected to turn out twine, rope, sacks, etc. J. E. Douglas, W. H. Coyle, etc., incorporators.

The Citizens Ice and Cold Storage Company is being incorporated at Dixon, Ill., with a capital of $50,000, and will erect an artificial ice plant. Glenn F. Coe, George A. Deland, H. S. Dixon, incorporators.

The Meriden (Conn.) Fire Arms Company has plans drawn for another factory to be used as a gun barrel and tempering department. It is also said that a new large power plant will be put in this summer.

Trade Catalogs.

Homestead Valve Manufacturing Co., Pittsburg, Pa. Price list of valves and locking cock. Illustrated, 3½x6, pp. 16, paper.

The Schwerdtle Stamp Co., 39 Cannon St., Bridgeport, Conn. Catalog of steel stamps, stencils, etc. Illustrated, 4x6, pp. 64, paper.

The Triumph Electric Co., Cincinnati, O. Bulletin No. 281, describing direct-connected generators, engine type. Illustrated, 6½x9½, pp. 11, paper.

Goulds Manufacturing Co., Seneca Falls, N. Y. Pamphlet describing and showing installations of Goulds pumps for fire service. 7x8, pp. 20, paper.

Baldwin Locomotive Works, Philadelphia, Pa. Record of Recent Constructon, No. 54. This is printed in English and French and shows the different types of locomotives for different kinds of service. Illustrated, 6x9, pp. 31, paper.

Harrisburg Foundry & Machine Works, Harrisburg, Pa. Catalog entitled "A System of Engines". This is a very attractive and comprehensive catalog describing the Fleming engines, steam turbines, superheaters. Illustrated, 6x9, pp. 57, paper.

The Bullard Machine Tool Co., Bridgeport, Conn. Catalog No. 30 describing standard and rapid production boring and turning mills, rapid production vertical turret lathes, turret machines and turret machine tools. This is a very handsome catalog, printed on fine coated paper and illustrated by excellent halftone engravings. 7x9, pp. 63, paper.

Miscellaneous Wants.

Advertisements will be inserted under this head at 25 cents a line each insertion. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded.

Caliper cat free. E. G. Smith, Columbia, Pa.

Cox Computers, 75 Broad st., New York.

Will buy or pay royalty for good patented machine or tool. Box 282, AMER. MACH.

Parallel attachments for drawing tables. F. G. Hobart, Beloit, Wis. Dealers or by mail.

Light and fine machinery to order; models and elec. work specialty. E. O. Chase, Newark, N. J.

Special machinery accurately built. Screw machine and turret-lathe work solicited. Robt. J. Emory & Co., Newark, N. J.

Wanted—A 36-inch Gleason bevel-gear planer in good condition. Address, giving full particulars. Box 369, AMER. MACHINIST.

Work wanted for a Cleveland automatic lathe; handles 2 in. and under. The Earle Gear and Machine Co., 141 Oxford st., Philadelphia, Pa.

Work Wanted—We are thoroughly equipped for building fine automatic machinery. The G. N. McKibbin Manufacturing Co., South Norwalk, Conn.

An experienced engineer desires to represent an American manufacturer in Great Britain this Summer on commission or otherwise. Address, R. J. S., 116 Stewart Avenue, Ithaca, N. Y.

Gray Iron Foundry in New England desires to take up the manufacture of some specialty requiring high-grade castings, preferably castings having intricate cores and requiring minimum of machining. Box 344, AM. M.

Mechanical organizer. I will visit your factory, study your methods and product, and offer suggestions that will enable you to save thousands of dollars every year. Terms on application. C. E. Tower, 1237 Monadnock, Chicago.

Wanted—Mechanical draftsmen, two or three men with first-class experience on ice and refrigerating machine design. Permanent $100 or more if ablity warrants. Engineering Agency, 1211 Monadnock Bldg. Chicago.

Wanted—Machine shop foreman, experienced in gasoline-engine construction, able to handle men, reduce cost, and systematize cost methods. Permanent $1200 to $1800. C4282 Engineering Agency, 1211 Monadnock Blk., Chicago.

Tool Catalog No. 22, 950 pages, bound in cloth. Greatest small-tool catalog ever published. Will be sent post-paid on receipt of $1. Money paid for catalog refunded with first purchase amounting to $10 or over. Book costs you nothing if you become a customer. Montgomery & Co., 109 Fulton st., New York City.

Notice to contractors—Sealed proposals suitably endorsed on envelope for repairs to heating system main building, East Division, Manhattan State Hospital, Ward's Island, N. Y. will be received up to 3 o'clock p. m., on Wednesday the 4th day of April, 1906, by the State Commission in Lunacy, at the Capitol, Albany, N. Y., when bids will be opened and read publicly. Drawings and specifications may be consulted and blank forms of proposals obtained at Manhattan State Hospital, Ward's Island or by application to G. L. Heins, State Architect, in the Capitol, at Albany, N. Y. Contracts will be awarded to the lowest responsible and reliable bidders unless the bids exceed the amount of funds available therefor, in which case the right to reject all bids is reserved. T. E. McGarr, Secretary State Commission in Lunacy, Albany.
Dated March 6, 1906.

For Sale.

For Sale—Foundry, Wood & Iron machine shops, Albion, N. Y. Box 74.

Complete mechanical scholarship, International Correspondence School. Fifty dollars cash. Address CX, 352, AMERICAN MACH.

For Sale—Half or whole interest in well established machine shop, with specialties to manufacture. A good opening for a practical man. Address Box 154, Bridgeport, Conn.

Business Opportunities.

A first-class mechanical engineer having a standard line of machinery to manufacture, wants parties to take up its manufacture. Box 355, AMERICAN MACHINIST

A young man (29) who has had a technical education and eight years' experience selling machine and electrical tools wants to represent one or two manufacturers in New York City. Advertiser has many personal acquaintances among machine-tool dealers and users and is at present representing one firm, whom he is privileged to offer as reference. Office is in center of machinery district, and would be conducted as New York office of parties represented on either salary or commission basis. Box 280, AMER. MACH.

Wants.

Situation and Help Advertisements only inserted under this head. Rate 25 cents a line for each insertion. About six words make a line. No advertisements under two lines accepted, and no advertisements abbreviated. The cash and copy should be sent to reach us not later than Saturday morning for the ensuing week's issue. Answers addressed to our care will be forwarded. Applicants may specify names to which their replies are not to be forwarded, but replies will not be returned. If not forwarded they will be destroyed without notice. Original letters of recommendation or other papers of value should ont be enclosed to unknown correspondents. Only bona fide situation want or help want advertisements inserted under this heading. Agency advertisements must be placed under Miscellaneous Wants.

Situations Wanted.

Classification indicates present address of advertiser, nothing else.

CONNECTICUT.

Expert accountant and office manager desires position. Familiar with all branches of office work. References. P. O. Box 55, Hartford, Conn.

IOWA.

Chief Draftsman; a mechanical engineer, at present chief draftsman with a large manufacturing concern in the west. Box 269, AMERICAN MACHINIST.

MASSACHUSETTS.

Man, 32 years of age, having had charge of lathe and planer departments, desires position. Is positively a hustler and a producer of work at minimum cost. References, Box 346, AMERICAN MACHINIST.

MICHIGAN.

Technical graduate, age 30, with shop, drafting room, and manufacturing experience, desires position as assistant to Engineer or Superintendent. Box 334, AM. M.

NEW JERSEY.

Draftsman, mechanical, solicits correspondence from parties, requiring services of capabe designer, chief draftsman or assistant superintendent. Wide experience. References. Box 348, AMERICAN MACHINIST.

Master mechanic, experienced toolmaker. Must move his machinery and tools. B. & S., Hendey and other machines. Railroad taking premises. Wants employment with or without outfit. Would build dies, molds, experimental or machine work. 705 Summit ave., Jersey City, N. J.

NEW YORK.

Competent mechanical draftsman, seeks position. Box 357, AMERICAN MACHINIST.

Position as foreman of machine shop, gas engines, marine or stationary, with executive ability. Box 368, AMERICAN MACHINIST.

First-class mechanical engineer and machine designer wants responsible position. Answer Box 365, AMERICAN MACHINIST.

Mechanical draftsman, first-class man on engines, contractors' machinery, jigs, tools, etc., wants position. C. W., 371, AM. M.

Tool room foreman familiar with modern methods, designer of fine tools, jigs, dies, gauges, etc. 20 years experience. Box 349, AMERICAN MACHINIST.

Man with long experience drop forging business, desires executive position. Superintendent or assistant. References. Box 347, AMERICAN MACHINIST.

General foreman, (36), responsible man, practical mechanic, successful in producing first-class work at satisfactory cost, varied experience, desires change. Box 354, AM. M.

A capable energetic young man (26), wants position as milling-machine foreman or assistant. Has made a special study of this work, and has 10 years practical experience, can operate all kinds of machines including B. & S., Cincinnati, Garvin and Kempsmith Universals. Thoroughly understands accurate and interchangeabe work, and absolutely of sober habits. Box 361, AMER. MACH.

A manager open for position must be within 2 hours' ride of New York City. Manufacturing business (metal trades or textiles), accountant and systematizer, age 35. Technical and business training, 15 years experience. Competent to assume full responsibilities. At present giving satisfaction. Furnish A-1 references. Address Manager Webster, 54 West 107th St., New York City.

OHIO.

Machine shop foreman desires change. Can handle work and men to advantage, experienced on electrical machinery and general machine work; would accept road position. Box 353, AMERICAN MACHINIST.

PENNSYLVANIA.

Foreman pattern-maker, 14 years experience would like to make a change. Six years with present firm, young man, sober and with family. Box 359, AMERICAN MACH.

Machinist and engineer with 10 years experience on steam plow and all kinds of up-to-date farming machinery, age 35, wants position. West preferred. A. W., 360, AMERICAN MACHINIST.

Technical graduate (31) with 10 years experience in the office and drafting room on electrical and other machinery, desires a position in the sales or advertising department of a reliable firm. Box 342, AMER. MACH.

Help Wanted.

Classification indicates present address of advertiser, nothing else.

CANADA.

Wanted Draftsmen—Experienced in air compressor and rock drill work. Good salaries for good men. Box 356, AMER. MACH.

CONNECTICUT.

Wanted—A first-class mechanical draftsman and designer accustomed to small, accurate, interchangeable work. Box 358, AM. M.

Wanted—Good detail mechanical draftsman to work on rolling mill and hydraulic work. Must be able to design and proportion details. Apply stating experience and wages expected. Farrel Foundry & Machine Co., Ansonia, Conn.

ILLINOIS.

Draftsman—We have positions now open for draftsmen. Call or address Western Electric Co., Chicago, Ill.

Wanted—Chief Draftsman and engineer having experience and practical familiarity with elevating, conveying and power-transmitting machinery, to take charge of drafting room in large concern manufacturing the line of machinery specified. Must be able to manage the drafting room to secure rapid, effective and accurate work. Engineering ability and as well keen appreciation of the manufacturing and commercial necessities of the business are desirable. For a man of the required training and capacity a permanent position is open where his value to the concern should steadily increase. Address with as full particulars as possible. Box 174, AMERICAN MACHINIST.

INDIANA.

Wanted—Manufacturing superintendent light machine manufacturer, good experienced man only need apply. Address R 310, AMERICAN MACHINIST.

IOWA.

Wanted—Three operators for screw machines in a Western city. State experience and kind of machines familiar with. Box 332, AMERICAN MACHINIST.

MASSACHUSETTS.

Wanted—Gear cutting expert, bevel gear and spiral man preferred. Boston Gear Works, New Shop, Norfolk Downs, Mass.

Wanted—Lathe and planer hands. Also several new men just out of their time as improvers. Apply Mason Machine Works, Taunton, Mass.

Wanted—Draftsman well experienced in designing ring oiler bearing. Only a first-class man will fill the requirement. B. F. Sturtevant Co., Hyde Park, Mass.

Wanted—A man who thoroughly understands operation of Gould & Eberhardt gear cutters. Must be familiar with cutters and know how to turn out the maximum product of high-grade work. Address "B," 362, AM. M.

Wanted—Foremen of experience on medium weight, accurate work, to take charge of planing and milling departments in up-to-date factory with modern equipment. Good positions for competent men. State age, experience, and wages desired. Box 367, AM. M.

Wanted—Foundry foreman for shop making all classes of castings from very light up to 3 tons weight, and employing over 100 molders when running full. Applicants must be thoroughly familiar with all grades of general machinery castings, and especially with printing-press work, and be able to produce sound and clean work, particularly beds and ink tables. Must also understand machine molding, and be well up in melting and mixing iron economically. Reply stating age, experience, references, and wages desired, to H. O. P. 351, AMERICAN MACHINIST.

MICHIGAN.

Wanted—Immediately first-class die makers and machinists. Steady employment. Michigan Machinery Mfg. Co., Ypsilanti, Mich.

Wanted—Ten first-class die makers. Experienced on drawing, forming and blanking dies. New Modern Shop. Good wages to good men. Inventors' Mfg. Co., Kalamazoo, Mich.

NEW JERSEY.

Draftsmen—We have positions now open for draftsmen. Call or address Henry R. Worthington, Harrison, N. J.

Wanted—A first-class mechanical draftsman; state experience and salary wanted. Box 881, AMERICAN MACHINIST.

Wanted—First-class lathe and vise men for small steel work. Steady work, good pay, no trouble. Twenty-five miles from New York City. Box 194, AMERICAN MACHINIST.

Wanted—An experienced mechanical draftsman accustomed to light machine design and tool work. State age, experience and salary expected. Box 315, AMERICAN MACHINIST.

We are increasing our tool-making department and solicit appications from toolmakers and machinists who are experienced on fine and complicated work. Apply to Victor Talking Machine Co., Camden, N. J.

NEW YORK.

Wanted—A first-class mechanical draftsman. State experience and salary. Box 364, AMERICAN MACHINIST.

Wanted—Draftsmen for jigs, fixtures, dies and shop tools. Apply to Mergenthaler Linotype Co., Brooklyn, N. Y.

Wanted—Experienced tool and gauge makers. Best wages paid for first-class men. Remington Arms Company, Ilion, N. Y.

Wanted—Die sinkers. Pay from $3.25 to $4.00 per diem. Apply to Board of Labor Employment, Navy Yard, Brooklyn, N. Y.

Draftsmen Wanted—Those experienced on engine work preferred. State age, nationality and wages expected. Box 311, AM. MACH.

Wanted—Manager, to have general oversight of bookkeeping, purchasing, costing and shipping departments of large manufacturing company. Box 327, AMERICAN MACHINIST.

Toolmakers—Wanted immediately, first-class toolmakers on high-grade dies, jigs, gauges and special fixtures for small machine manufacture. Send references to Drawer 7, Syracuse, N. Y.

Wanted—Mechanical draftsman with at least two or three years experience at detail work. Attractive salaries to good men. State age and experience. Address Box 366, AMERICAN MACHINIST.

Wanted—A first-class man on Niles Boring, Drilling and Milling machine. Good wages and steady work for first class man. Address, De La Vergne Machine Company, Foot of East 138th Street, New York City.

Machinists—For floor work. Permanent employment for good men. Wages $2.50 per day; 9 hour work day; time and half for overtime, double time for holidays. Location 25 miles from New York City. Box 268, AMERICAN MACHINIST.

Milling Machine Operators. First class operators on Brown & Sharpe Universal Milling Machines on tool work. Must be able to set up machines and work from drawings. Apply to the Western Electric Co., 57 Bethune St., New York City.

Wanted in an architect's office, a graduate in mechanical or civil engineering, who has had some experience, to assist in laying out heating electrical and plumbing work. Salary twenty-five dollars. State experience and references. Box 350, AMER. MACH.

Fort Totten, N. Y., March 10, 1906. Wanted—Master Electricians for Coast Artillery, U. S. Army. Graduates of standard schools of technology or others of equivalent theoretical education, and three years practical experience with steam and electricity, under 33 years of age and unmarried. Pay and allowances as follows: Pay $75.00 per month. Allowances: house, food, clothing, fuel, light, medical attendance, etc. After 30 years service, retirement on three quarters pay and allowances. For further particulars, apply to Secretary, School of Submarine Defense, Fort Totten, N. Y.

OHIO.

Wanted—First-class mechanical draftsmen, experienced in machine-tool work. The Niles Tool Works Co., Hamilton, Ohio.

Wanted—Draftsman. One familiar with automobile work preferred. None but first-class draftsmen need apply. Box 340, AM. M.

Wanted—Foreman for body and running gear finishing and assembling department in large automobile works. Must have had previous experience in this line. Box 339, AMERICAN MACHINIST.

Wanted—Foreman experienced in gas engine work to take charge of engine assembling department in large automobile factory. Must be a hustler and come well recommended. Box 337, AMER. MACHINIST.

Wanted—Foreman to take charge of repair department in automobile factory. Must have had experience with high grade American and foreign cars and be able to handle men to advantage. No others need apply. Box 338, AMERICAN MACHINIST.

Wanted—First-class man to take charge of designing of up-to-date jigs and fixtures for machine-tool work. Must be capable of giving instructions in use of the same. None but parties having practical shop experience need apply. State experience and salary wanted. Address Cincinnati Milling Machine Co., Cincinnati, O.

PENNSYLVANIA.

Wanted—First-class draftsman, familiar with paper-mill machinery. Box 331, AM. M.

Wanted—First-class foreman for machine shop. Will have charge of machinery only. Address, Ball Engine Co., Erie, Pa.

Wanted—Foreman for foundry employing 25 to 75 men, making boiler and engine castings. State age, wages expected, married or single. Address, "Foreman," 345, AM. M.

Wanted—First-class instrument and tool makers; also large machine tool operators. Address Employment Department, Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa.

Wanted—A number of mechanical draftsmen; those with experience in electrical apparatus, generators or motors preferred. Only first-class men need apply. Address Chief Draftsman, Westinghouse Electric and Manufacturing Co., East Pittsburg, Pa. (P. O. Box 911.)

The Monotype Company maintains a free school for training young machinists to op-

erate its type casting and composing machines. The demand for Monotype operators is so great that it receives more applications for places in its school than can be filled. In making selections, these qualifications carry most weight; character, common sense, experience with automatic machinery, (or) printing-office experience, or type foundry experience. Full particulars will be furnished to inquirers who furnish full particulars about themselves. Lanston Monotype Machine Co., 1231 Callowhill St., Philadelphia, Pa.

RHODE ISLAND.

Toolmakers Wanted—First-class workmen on jig and fixture work for light high-grade machinery. Permanent employment to competent workmen. Apply to the Taft-Peirce Mfg. Co., Woonsocket R. I.

WISCONSIN.

As the result of doubling its new West Allis Plant, Allis-Chalmers Co., of Milwaukee, needs more pattern makers, machinists and moulders.

Wanted—Machinists ambitious to be foremen or sub-foremen. Our growing automobile business often furnishes opportunity for advancement. Thomas B. Jeffery & Co., Kenosha, Wis., Rambler Automobiles.

Large concern building excavating and railway machinery wants to correspond with first-class mechanical draftsmen with view to filling future vacancies as they occur; wants men now employed; give full experience and reason for changing; shop experience great advantage; all letters acknowledged and held confidential Box 919, AM. M.

WEST OF MISSISSIPPI.

Experienced punch and die makers those with experience with sub-press work preferred. Steady work and first class wages guaranteed to good men. Box 318, AM. M.

Draftsman with experience in light automatic machinery, with some experience in designing tools for the manufacture of same. Exceptional good opportunity for a good practical man. No others need apply. Box 317, AMERICAN MACHINIST.

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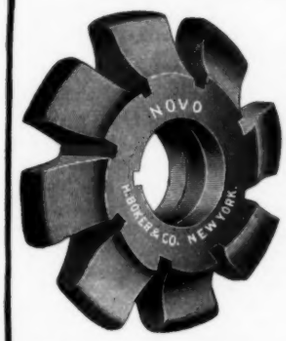

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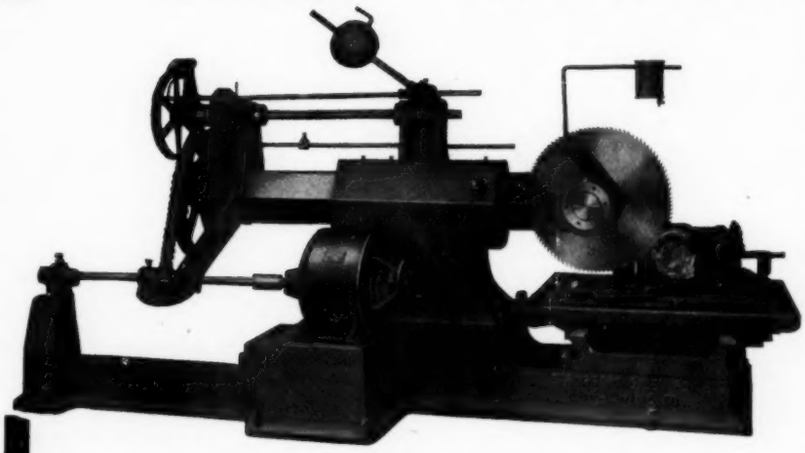

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